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**Mammals of the Swift Current Creek Local Fauna
(Eocene: Uintan, Saskatchewan)**



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by John E. Storer

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ABSTRACT

The Swift Current Creek Local Fauna, Cypress Hills Formation of Saskatchewan, is a Uinta C equivalent (later Eocene: late Uintan Land-Mammal Age). The fauna inhabited a wide river valley in the Great Plains, probably dominated by closed-canopy woodland formations. Mammalian diversity in both species richness and equitability of representation was high, indicating ecological stability. The preserved sample represents predominantly late spring or early summer mortality. Fossils were transported and deposited in a braided stream at the time of peak seasonal rainfall and stream discharge. Fifty-three mammalian taxa are represented, including new genera Wallia (Insectivora: Proscalopidae) and Ibarus (Artiodactyla: Leptochoeridae), and new species Didelphodus serus, Thylacaelurus campester, Wallia scalopidens, Auxontodon processus, Ibarus ignotus, Microparamys solidus, Pseudocylindrodon citofluminis, "Namatomys" fugitivus, Protadjidaumo altilophus, Janimus mirus, and Procaprolagus vusillus



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INTRODUCTION

The Swift Current Creek Local Fauna has been known for more than fifty years. Contributions to its knowledge (Russell and Wickenden, 1933; Russell, 1965a) established some important details, based on limited material from surface collecting at a single, conglomeratic locality.

The local fauna has tantalized paleontologists. Swift Current material is nearly the only later Eocene vertebrate evidence from the Great Plains region, yet the available specimens were few enough to leave most of the fauna unknown.

The Saskatchewan Museum of Natural History began regular visits to the locality in 1976. 1977 and 1978 reconnaissance produced a few fossils from a nearby road cut, and revealed an unconsolidated lens in the original site that appeared suitable for screening. In 1980, the Swift Current Creek Locality was dry-screened, producing most of the specimens discussed here.

A 1982 sabbatical from the Saskatchewan Museum of Natural History, Saskatchewan Department of Culture and Recreation, allowed me to make the necessary identifications, and study the mammalian fauna as a unit. This monograph includes my taxonomic, biostratigraphic, and paleoecological conclusions, with a summary of available geological evidence.

GEOLOGY

Deposits of later Eocene age southeast of the City of Swift Current, Saskatchewan, were first described by Russell and Wickenden (1933). Only one of the exposures they examined produced fossils: an outcrop high in the valley of Rushlake Creek about 13 km east-southeast of Swift Current (op. cit., p. 54) yielded vertebrates that appeared to be comparable with those of the Myton Pocket, Uinta Formation (Uintan) of Utah.

These deposits, named the Swift Current beds (loc. cit.) or Swift Current Creek beds (Russell, 1950, p. 52), were included within the Cypress Hills Formation on lithological grounds by Vonhof (1969, p. 87). Recent geological maps (Whitaker and Pearson, 1972; Macdonald and Broughton, 1980) have followed Vonhof's assignment, and I adopt it here.

Although there are many outcrops of Cypress Hills Formation in the area southeast of Swift Current, only one additional locality has produced fossil mammals that are demonstrably Eocene. One tooth apiece of an oromerycid and Leptoreodon were collected at a conglomeratic exposure about 1 km north of Russell and Wickenden's locality. Otherwise all fossils considered here are from the originally described section (Russell and Wickenden, 1933, p. 54).

The Cypress Hills Formation "comprises gravel and conglomerate beds, sand and sandstone beds, volcanic ash and bentonite, silt, clay and marl deposits" (Vonhof, 1969, p. 88). Nearly all the exposed deposits, and all deposits associated with fossil vertebrates, are sands, gravels, and conglomerates and sandstones with calcareous cement. Vonhof (1965a, b, 1969) described depositional features characteristic of braided streams, and concluded from directions of cross-bedding in sands, and orientations of disc-like and ellipsoidal pebbles, that streamflow was east-northeast.

Sands and gravels are predominantly (usually near 90%) quartzite and chert, with minor quantities of argillite, sandstone, and quartz, and less than 1% miscellaneous rock types, including conglomerates, limestones, porphyries, dolomites, chert breccias, jaspers, and agates (Vonhof, 1969, p. 112). Mineral composition and Palaeozoic fossils preserved in cherts indicate a source in the Rocky Mountains of western Montana, near the headwaters of the present Missouri River (op. cit., p. 119). Apparently little material was locally derived, although some of the heavy minerals may have been reworked from the underlying late Cretaceous (op. cit., p. 120). Predominance of silicates and low representation of carbonates was "likely due to the great distance of

transportation (about [320 km] or more)" (loc. cit.). Cementation of conglomerates and sandstones was postdepositional, may have occurred during the Quaternary, and may continue at present (Kupsch and Vonhof, 1967).

The Eocene deposits were laid down in a broad, easterly-trending valley carved at least 61 metres deep into late Cretaceous marine shales of the Bearpaw Formation (Vonhof, 1969, pp. 89-90). Both known fossil localities are near 792 m present elevation above sea level, and lie in the thalweg of the ancient valley (op. cit., figs, 6, 8).

100 km to the southwest, on the Cypress Hills Plateau, deposits of the Cypress Hills Formation are at least 275 m higher in present elevation (Russell and Wickenden, 1933, p. 54), and overlie an erosional surface on the Paleocene Ravenscrag Formation and latest Cretaceous Frenchman Formation that "approximates a plane which slopes toward the east" (Vonhof, 1969, p. 90), and shows a maximum of 15 m local relief. Confirmed Eocene exposures are not known on the Cypress Hills Plateau, and fossiliferous localities have been assigned to the Chadronian (early Oligocene) and Hemingfordian (early Miocene) (general summary in Storer, 1978c).

Vonhof (1969, p. 91) cited thicknesses of 4.5 to more than 80 metres for the Cypress Hills Formation southeast of Swift Current, but it is impossible to be certain that all these deposits are Uintan. The section at Rushlake Creek described by Russell and Wickenden (1933, p. 54) is more than 15 m thick, with Uintan fossils occurring in the upper beds, giving a minimum figure for Eocene deposition in the deepest part of the valley.

HISTORY OF COLLECTING AND RESEARCH

R.T.D. Wickenden, Geological Survey of Canada, discovered the Swift Current Creek Locality in 1930, and collected fossil vertebrates there. L.S. Russell (1965a, p. 7) listed collectors who had worked the locality through 1956.

In the late 1950's and early 1960's B.A. McCorquodale and A.E. Swanston collected material for the Saskatchewan Museum of Natural History on various occasions. Paul Ramaekers collected at the Swift Current Creek Locality for the Royal Ontario Museum in 1968, and for SMNH at various times through the 1970's. John Storer (SMNH) worked at the locality with R.W. Tillie in 1976, M.K. Baker in 1977, David Baron and Keith Roney in 1978, and David Baron and William Russon in 1980. This last expedition was the first to attempt large-scale screening of matrix from uncemented sand lenses, and produced most of the specimens discussed here.

Russell and Wickenden (1933) first described the geology and fossils of the Swift Current Eocene, including 14 mammalian taxa. Fraser et al. (1935, pp. 56, 118-120, 128), Russell (1950, 1954b, 1957, 1965a, b), and Storer (1978a, c) summarized previous work and commented on the geology and correlation of the deposits. Vonhof (1965a, 1969) described the geology of the Cypress Hills Formation in theses on Tertiary sands and gravels in the Canadian Plains, but published only his findings on the Cypress Hills Plateau (1965b).

Russell (1965a) described additions to the Swift Current mammalian fauna, increasing the known assemblage to 16 taxa. Krishtalka (1979) included Swift Current specimens in his revision of late Eocene Hyopsodus: Gazin (1968) had earlier discussed the material and refigured the holotype of H. fastigatus from Swift Current. Radinsky (1963, p. 70) commented on the identification of a Swift Current tapiroid. Wood (1962, p. 241) and Storer (1978a) described rodent material from the fauna. Burke (1934b, p. 407) and Dawson (1970, p. 230) discussed the possible relationships of a Swift Current lagomorph.

COLLECTING METHODS

Most fossils collected at the Swift Current Creek Locality before 1980, and both specimens from the nearby road cut, were recovered from the surface. Despite repeated visits by collectors, exposures yielded less

than 100 identifiable mammalian specimens to conventional prospecting methods, because the area of fossiliferous outcrop is small and conglomeratic, exposing little newly-eroded material.

Paul Ramaekers (ROM) in 1968, and John Storer and Murvin Baker (SMNH) in 1977, made collections by passing matrix through hand screens, and inspecting the residue left in the screens. Relatively small amounts of matrix can be inspected in this manner, but it is possible to recover fossils that would not be accessible to standard prospecting techniques.

Nearly all the fossils discussed in this account, including all specimens with prefix P1654, were collected in 1980 by power-screening. This technique involves a double-cylinder rotary sifting machine of the kind described by Russell (1970, 1976). This machine consists of two cylindrical screens, one inside the other, turned at moderate speed by an electric motor: the inner screen has 5-mm apertures, the outer screen 1-mm apertures. Unconsolidated material is inserted into the inner screen, and residues remaining in both screens are collected separately for inspection. The machine is fitted with chutes for insertion of matrix and removal of residues, and is set at a slight tilt for continuous operation. Fossils are removed from the coarser residue at the site. The 1-5 mm size fraction is taken to the laboratory, separated again through size 10 and 20 hand screens, and examined under a microscope. Material that passes through the 1-mm screen is left at the site.

The power-screening method was invented by Bruce McCorquodale and Albert Swanston (SMNH) in the early 1960's. Realizing that improved yields of fossils would be gained by inspecting large quantities of sediment, but that underwater washing methods described by Hibbard (1949) would remove very little fine material from sands and gravels, they built a single-cylinder rotary screen turned by gasoline engine. This machine was used at the Calf Creek Locality near Eastend (early Chadronian or earliest middle Chadronian) from 1962 to 1967, and was the means of recovering thousands of fossils. The original machine was

built of wood, and was awkward but effective. The finest screen used was flyscreen, and aperture size was probably never less than 1.5 mm, creating a sample bias against very small fossils.

Loris Russell and John Storer (ROM) built hand-turned, single-cylinder screens in 1967-68 to collect small fossils from the Kleinfelder Farm Locality (Wood Mountain Formation, late Barstovian). Again the screen frames were wooden and flyscreen was used. Probably the samples described by Storer (1975) are also biased against fossils whose secondary diameters are less than 1.5 mm.

In 1970 L.S. Russell introduced a double-cylinder machine, with steel frame and stainless steel screens. He used this machine to recover nearly 12 tonnes of Kleinfelder Farm concentrate (Russell, 1976). Use of stainless steel screens made smaller mesh sizes available, down to about 1-mm apertures, thereby reducing sample bias considerably. The SMNH machine used in 1980 was modeled after Russell's power screen.

It is difficult to estimate sample bias introduced by the power-screening technique. Certainly there is a bias against recovery of the smallest fossils, because much fine-grained material drops through the screens and is not inspected. Aperture size of the finest screen sets a limit: fossils with secondary diameters smaller than the aperture will often not be recovered. But smaller specimens are not totally excluded, unless repeated screening or excessive violence are used. Some teeth of "Namatomys," for example have secondary diameters smaller than 1 mm, yet were collected with the power screen. That very few fossils reported here are in the size range under 1 mm indicates that a considerable sample bias has been caused by the collecting method.

Removal of fossils from concentrate by microscopic inspection may lead to sample bias, but this has not been demonstrated. Separation with high-density liquids would presumably give perfect recovery of fossils from the concentrate, but SMNH has inadequate fume-exhaust equipment for the technique. I assume, however, that microscopic inspection merely increases the time required to recover fossils.

METHODS AND MATERIALS

Reported measurements are maxima for the tooth crown or other element. Anteroposterior diameters (AP) were taken parallel to the anteroposterior axis of the tooth. Buccolingual diameters (BL: also BLmet, buccolingual diameter of metalophid; BLhyp, buccolingual diameter of hypolophid; BLtri, buccolingual diameter of trigonid; BLtal, buccolingual diameter of talonid) were taken perpendicular to the anteroposterior axis. Height of crown (HC) was measured at the paracone of upper cheek teeth, and at the protoconid of lower cheek teeth, unless otherwise noted: HC applies to only unworn or nearly unworn teeth.

The anteroposterior axis of marsupial upper molars was assumed to be perpendicular to the anterior crown border. Anteroposterior axes of proteutherian and insectivore teeth as defined by Novacek (1976, p. 8) were adopted for this study, and axes of dermopteran, chiropteran, and carnivore teeth were determined similarly. Buccolingual diameters of rodent and lagomorph upper teeth are apparent maxima as seen in ventral view of the occlusal surface, with the lens parallel to the occlusal surface.

Dental measurements of "small mammals" were taken with a Bausch and Lomb micrometer disc (no. 31-16-10) inserted in one eyepiece of an Olympus SZ III binocular microscope. The micrometer disc was calibrated with a Bausch and Lomb stage micrometer (2 mm in intervals of 0.1 mm, 0.2 mm in intervals of 0.01 mm). These measurements are given to the nearest 0.01 mm.

Measurements of jaws and larger teeth were made with hand-held dial calipers (Fowler Type 6921), and are given to the nearest 0.1 mm.

In lists of measurements, the object measured is given first, then the diameter measured, with number of specimens in parentheses, mean, observed range (OR), and for suites of five or more measurements, coefficient of variation (CV).

Designations of cheek teeth are in the traditional style (P1-4, M1-3 for Allotheria and Eutheria; P1-3, M1-4 for Metatheria). McKenna (1975) has pointed out that at least six premolar and at least six molar loci are primitive for the Mammalia, with five premolars and at least six molars primitive for Theria. It is certain that tooth designations as used here are not compatible with dental positions in primitive mammals, and do not reflect the origins of the teeth. Such designations are convenient, however, for comparisons with advanced mammals of the orders represented in this fauna.

Specimens cited are in collections of the American Museum of Natural History, New York (AMNH); Carnegie Museum of Natural History, Pittsburgh (CM); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); National Museum of Natural Sciences, National Museums of Canada, Ottawa (NMC); Royal Ontario Museum, Toronto (ROM); and Saskatchewan Museum of Natural History, Regina (SMNH). Registration numbers cited with only prefix P are SMNH numbers.

SYSTEMATIC PALEONTOLOGY

Class Mammalia
Subclass Allotheria
Order Multituberculata
Family Neoplagiaulacidae

Ectypodus lovei (Sloan, 1966)

Material. LM¹, P1654.1; LP₄, P1654.2; RP₄, P1654.3-5; LM₁, P1654.6.

Discussion. This sample compares closely with previously described Ectypodus lovei. M¹ (Fig. 1A; cusp formula 8:9:5; AP, 2.14; BL, 1.11) and M₁ (Fig. 1B; cusp formula 7:4; AP, 1.68; BL, 1.00) are well within the ranges of Badwater Eocene E. lovei (Krishtalka and Black, 1975, table 1), and are slightly smaller than Eocene-Oligocene Ectypodus sp.

P₄, known from one anterior fragment (height of first serration above enamel border, 1.02) and three posterior fragments, is referred to the same species.

Ectypodus lovei is known to range from late Uintan (Sloan, 1966; Krishtalka and Black, 1975) to early Chadronian (Krishtalka et al., 1982). A possibly later Saskatchewan record is represented by ROM 23,233, LM¹ (cusp formula 9:8:4; AP, 2.14; BL, 1.00), from a locality 2.7 km ENE of the source of the Calf Creek Local Fauna. If this specimen is contemporaneous with the Calf Creek Local Fauna, its age is near the lower-middle Chadronian boundary (Storer, 1981a).

Thus Ectypodus lovei and Ectypodus sp. may be contemporaneous in all but the late Uintan, where E. sp. is not known. Separation of the species is tentative (Krishtalka et al., 1982, p. 792), and the new Saskatchewan records, typical for E. lovei, do not resolve the taxonomic problem.

Subclass Theria
Infraclass Metatheria
Superorder Marsupialia
Order Marsupicarnivora
Family Didelphidae

Peratherium marsupium (Troxell, 1923)

Material. LM¹, P1654.7-9; RM¹, P1654.10-14; LM², P1654.15-16; RM², P1654.17-19; LM³, P1654.20-24; LM⁴, P1654.25; RM⁴, P1654.26-29; LP₃, P1654.30; RP₃, P1654.31; LM₁, P1654.32; RM₁, P1654.33; LM₂, P1654.34-40; RM₂, P1654.41-42; LM₃, P1654.43-44; RM₃, P1654.45-46; LM₄, P1654.47-48; lower molar fragments, P1654.49-82.

Discussion. This suite of didelphid material is indistinguishable from Badwater Peratherium cf. P. marsupium as described by Setoguchi (1975). Krishtalka and Stucky (1983a, b) referred the Badwater material to P. marsupium, and I follow their example.

I also follow Krishtalka and Stucky (op. cit.) in referring the species to Peratherium, rather than Herpetotherium (Crochet, 1977). I do so with misgivings: Herpetotherium is a valid genus (Fox, 1983), but its diagnostic characters are in the anterior dentition.

Peratherium valens of the Cypress Hills Oligocene (Russell, 1972, p. 6) is only slightly smaller than P. marsupium, and described material compares well in dental pattern with Swift Current specimens. Description of a large sample of P. valens from the Calf Creek Local Fauna, in preparation by L.S. Russell, will clarify the status of the species. I think that P. valens is closely related to P. marsupium.

Measurements. M¹ AP(6), mean 2.35, OR 2.18-2.45, CV 4.7; BL(6), mean 2.41, OR 2.26-2.49, CV 3.7; HC at metacone(1), 1.54. M² AP(4), mean 2.44, OR 2.32-2.53; BL(4), mean 2.63, OR 2.51-2.79; HC at metacone(1), 1.67. M³ AP(4), mean 2.49, OR 2.37-2.61; BL(4), mean 2.71, OR 2.51-2.79; HC at metacone(2), mean 1.60, OR 1.51-1.69. M⁴ AP(4), mean

1.31, OR 1.22-1.38; BL(4), mean 2.54, OR 2.37-2.67. P_3 AP(2), mean 1.88, OR 1.80-1.95; BL(2), mean 0.90, OR 0.90-0.90. M_1 AP(2), mean 2.38, OR 2.38-2.38; BLtri(2), mean 1.35, OR 1.27-1.42; BLtal(2), mean 1.53, OR 1.47-1.58. M_2 AP(7), mean 2.50, OR 2.43-2.67, CV 3.6; BLtri(9), mean 1.38, OR 1.30-1.46, CV 4.3; BLtal(9), mean 1.44, OR 1.35-1.56, CV 5.6. M_3 AP(4), mean 2.49, OR 2.43-2.57; BLtri(4), mean 1.43, OR 1.38-1.52; BLtal(4), mean 1.46, OR 1.42-1.52; HC(1), 1.86. M_4 BLtal(1), 0.84.

Peratherium knighti McGrew, 1959

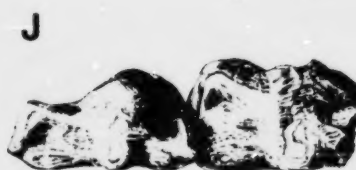
Material. LM^1 , P1654.84; LM^2 , P1654.86; RM^2 , P1654.92-95; upper molar fragments, P1654.106, P1654.108, P1654.115-117; LP_3 , P1654.121-123, P1654.128; RP_3 , P1654.124, P1654.125; LM_2 , P1654.140, P1654.141; RM_2 , P1654.144; RM_3 , P1654.146, P1654.148, P1654.149; lower molar fragments, P1654.161, P1654.162, P1654.164, P1654.173, P1654.176, P1654.180, P1654.194, P1654.195, P1654.199, P1654.206, P1654.208-210.

Discussion. Krishtalka and Stucky (1983a, b) gave criteria for separating Peratherium knighti and P. innominatum in Badwater and other samples. Swift Current specimens have been identified accordingly.

As at Badwater, P. knighti teeth are slightly larger than those of P. innominatum. In upper molars, styler cusp A is attached to the strong anterior cingulum; styler cusps C and D occupy a single large, bulbous base; and the buccal notch is weaker than in P. innominatum.

Measurements. M^1 AP(1), 1.94. M^2 BL(1), 2.11. P_3 AP(3), mean 1.66, OR 1.52-1.75; BL(5), mean 0.74, OR 0.70-0.78, CV 4.1. M_2 AP(2), mean 2.14, OR 2.07-2.20; BLtri(3), mean 1.12, OR 1.09-1.14; BLtal(3), mean 1.26, OR 1.21-1.32. M_3 AP(3), mean 2.02, OR 2.01-2.04; BLtri(3), mean 1.12, OR 1.11-1.13; BLtal(3), mean 1.16, OR 1.08-1.21.

Fig. 1. A-B, Ectypodus lovei; A, LM¹, P1654.1; B, LM₁, P1654.6. C-F, Peratherium marsupium; C, RM¹, P1654.10; D, RM², P1654.17; E, LM³, P1654.20; F, LM₃, P1654.44. G-J, Peratherium innominatum; G, LM¹, P1654.83; H, RM², P1654.90; I, LM³, P1654.96; J, LM₃₋₄, P1654.152. K, Peradectes californicus, RM¹, P1654.213. L, Peradectes cf. P. minutus, LM₃, P1654.214. M, "Peradectes" mcgrewi, LM², P1654.219. Anterior to left in A, E, G, I, M, to right in B-D, F, H, J-L; buccal to top of page. Scales 1 mm.



Peratherium innominatum Simpson, 1928

Material. LM¹, P1654.83; LM², P1654.85, P1654.87-89; RM², P1654.90, P1654.91; LM³, P1654.96-99; RM³, P1654.100, P1654.101; LM⁴, P1654.102; RM⁴, P1654.103, P1654.104; upper molar fragments, P1654.105, P1654.107, P1654.108, P1654.110-114, P1654.126, P1654.127; LP₃, P1654.118, P1654.119; RP₃, P1654.120; LM₁, P1654.129-132; RM₁, P1654.135, P1654.137, LM₂, P1654.138, P1654.139, P1654.142; RM₂, P1654.143, LM₃, P1654.145; RM₃, P1654.147, P1654.150, P1654.151; L mandibular fragment with M₃₋₄, P1654.152; LM₄, P1654.153-157; lower molar fragments, P1654.158-160, P1654.163, P1654.165-172, P1654.174, P1654.175, P1654.177-179, P1654.181-193, P1654.196-198, P1654.200-205, P1654.207, P1654.211, P1654.212.

Discussion. Teeth identifiable as Peratherium innominatum (Krishtalka and Stucky, 1983a, b) are common at the Swift Current Creek Locality. These teeth are slightly smaller than corresponding elements of P. knighti.

In upper molars, styler cusp A protrudes sharply anterad and is separate from the anterior cingulum; styler cusp B is larger than combined styler cusps C and D; styler cusps C and D are fused and form an elongate ridge; and the buccal notch is more prominent than in P. knighti.

Measurements. M¹ AP(1), 1.73; BL(1), 1.49. M² AP(5), mean 1.81, OR 1.74-1.85, CV 2.5; BL(3), mean 1.95, OR 1.87-1.99. M³ AP(3), mean 1.85, OR 1.81-1.91; BL(4), mean 2.09, OR 1.96-2.19. M⁴ AP(2), mean 1.01, OR 0.97-1.05; BL(3), mean 2.01, OR 1.94-2.10. P₃ AP(1), 1.24; BL(1), 0.52. M₁ AP(6), mean 1.75, OR 1.69-1.85, CV 3.2; BLtri(6) mean 0.94, OR 0.90-1.00, CV 4.1; BLtal(6), mean 1.04, 1.01-1.10, CV 3.4. M₂ AP(1), 1.83; BLtri(3), mean 0.99, OR 0.96-1.02; BLtal(3), mean 1.08, OR 1.05-1.12. M₃ AP(5), mean 1.80, OR 1.71-1.90, CV 4.8; BLtri(5), mean 1.04, OR 0.98-1.11, CV 5.0; BLtal(5), mean 1.05, OR 0.97-1.14, CV 6.8;

HC(1), 1.70. M_4 AP(4), mean 1.80, OR 1.73-1.84; BLtri(4), mean 1.01, OR 0.94-1.05; BLtal(4), mean 0.70, OR 0.69-0.74; HC(3), mean 1.63, OR 1.60-1.65.

Peradectes californicus (Stock, 1936)

Material. RM_1^1 , P1654.213; RM_1 , P1654.134, P1654.136; LM_3 , P1654.215; RM_3 , P1654.216

Discussion. A few specimens are referable to Peradectes californicus as defined by Krishtalka and Stucky (1983b). Size is small; upper molars (Fig. 1K) are less dilambdodont than in Peratherium, with more conical para- and metacone and less distinct styler cusps; and lower molars have a more anteriorly directed paraconid, large metaconid, concave buccal cristid obliqua, high hypoconid, and less posteriorly displaced hypoconulid nearly equal in size to the entoconid.

Measurements. M_1^1 AP(1), 1.45; BL(1), 1.41. M_1 AP(2), mean 1.48, OR 1.44-1.52; BLtri(2), mean 1.80, OR 1.79-1.80; BLtal(2), mean 0.93, OR 0.87-0.99. M_3 AP(2), mean 1.41, OR 1.36-1.45; BLtri(2), mean 0.78, OR 0.75-0.81; BLtal (2), mean 0.76, OR 0.73-0.78.

Peradectes cf. P. minutus (McGrew, 1937)

Material. LM_1 , P1654.133; LM_3 , P1654.214; lower molar fragments, P1654.217, P1654.218.

Discussion. Some lower molars (Fig. 1L) are slightly larger than similar specimens referred to P. californicus, and I refer them to Peradectes cf. P. minutus following Krishtalka and Stucky (1983b).

Measurements. M_1 AP(1), 1.71; BLtri(1), 0.90; BLtal(1), 0.93; HC(1), 1.53. M_3 AP(1), 1.72; BLtri(1), 0.93; BLtal(1), 1.81; HC(1), 1.52.

"Peradectes" mcgrewi (Russell, 1972)

Material. LM^2 , P1654.219.

Discussion. The only known Swift Current specimen (Fig. 1M) is slightly larger than the holotype (Russell, 1972, p. 7) from the Chadronian of the Cypress Hills Formation. Unreported specimens from the Chadronian Calf Creek Local Fauna (Russell, in prep.) are nearly identical.

Russell is erecting a new genus for this species, and I refer it to "Peradectes" only for convenience. "Peradectes" mcgrewi almost certainly belongs to the tribe Peradectini: I leave it to Russell to elucidate its closer relationships.

Measurements. M^2 AP(1), 4.95; BL(1), 4.98.

Infraclass Eutheria
Order Proteutheria
Family Leptictidae

Palaeictops borealis (Russell, 1965a)

Protictops? borealis Russell, 1965a, p. 7.

Type. Holotype RM¹, ROM 1676, Swift Current Creek Local Fauna.

Material. Holotype and RdP⁴, P1654.220; RP⁴, P1654.221-222; LM₁ or M₂, ROM 23,565, P1654.223-224; RM₁ or M₂, ROM 1685, P1654.225-226.

Description. dP⁴ (Fig. 2A) slightly lower-crowned than P⁴; posterior border sharply concave; parastyle, metastyle projecting sharply anterad, posterad; hypocone large but low, isolated on posterolingually projecting, triangular platform, sending low posterior cingulum to base of metaconule; anterior cingulum short, low; buccal cingulum weak; paraconule, metaconule prominent, conical, anterolingual to paracone, metacone.

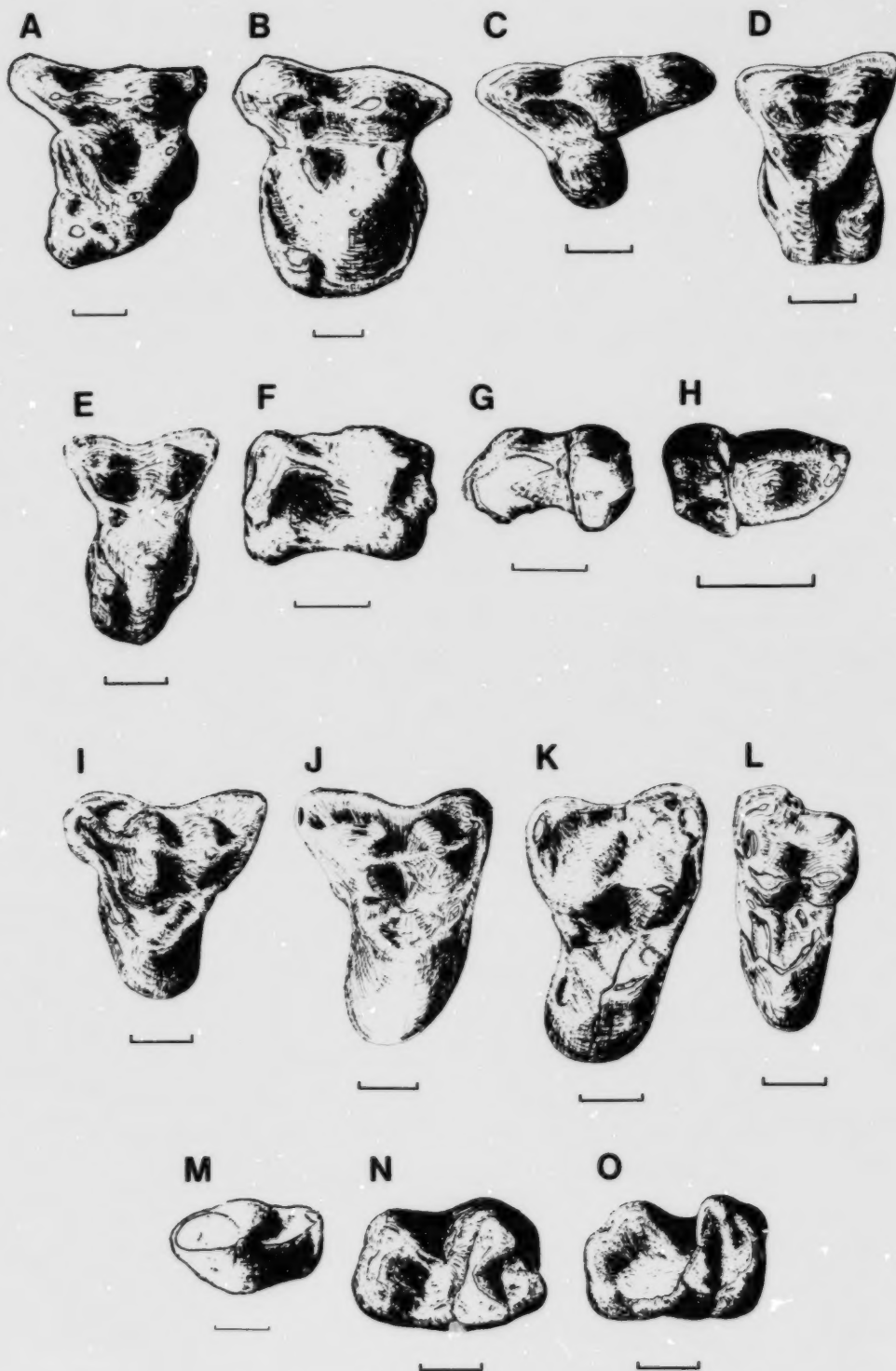
P⁴ (Fig. 2B) slightly transverse; paracone close to metacone, near middle of buccal border; parastyle low, projecting strongly anterad; hypocone platform curved posterolingually; anterior cingulum large but low, weak; para- and metaconule prominent, conical.

M¹, lower molars as described by Russell (1965a).

Discussion. Russell (1965a) referred this species to Protictops as an expedient: he was convinced (as am I) that the material does not represent Leptictis (= Ictops). But Lillegraven et al. (1981, pp. 9, 46) concluded that the lost type specimen of Protictops is indeterminate and possibly represented a geolabidid, and that the genus should be regarded as a nomen dubium.

Among valid leptictid genera, P. borealis comes closest to fitting the diagnosis of Palaeictops. Novacek (1977, p. 13) included P⁴ "and upper molars not transverse nor anteroposteriorly compressed, with low bulbous cusps, very narrow styler shelves, small but distinct hypocones, very short anterior cingula, and conules situated at base of paracone and metacone....Molar trigonids not as elevated as in Prodiacodon."

Fig. 2. A-B, Palaeictops borealis; A, RdP⁴, P1654.220; B, RP⁴, P1654.221. C-G, Leptictis sp.; C, RP³, P1654.229; D, LM¹, P1654.231; E, RM², P1654.234; F, LM₁ or M₂, P1654.238; G, LM₃, P1654.244. H, Apatemys hendryi, RM₃, P1654.246. I-O, Didelphodus serus; I, LP⁴, P1654.247; J, RM¹, P1654.249 (holotype); K, RM², P1654.250; L, LM³, P1654.252; M, RP₄, P1654.253; N, LM₁ or M₂, P1654.254; O, LM₃, P1654.257. Anterior to left in D, H, I, L, M, to right in A-C, E-G, J, K, N, O; buccal to top of page. Scales 1 mm.



P. borealis has larger hypocones, protruding more strongly posterolingual than in described congeners, but its major similarities are to Palaeictops. P. borealis is the largest species of the genus, and has proportionally wide lower molars.

Measurements. dP^4 AP(1), 4.00; BL(1), 4.24. P^4 AP(2), mean 4.40, OR 4.38-4.42; BL(2), mean 4.93, OR 4.88-4.98. M^1 AP(1), 4.40; BL(1), 4.75. M_1 or M_2 AP(3), mean 4.10, OR 3.94-4.37; BLtri(3), mean 3.07, OR 2.80-3.21; BLtal(4), mean 3.09, OR 3.00-3.29.

Leptictis sp.

Material. LP^3 , P1654.227-228; RP^3 , P1654.229-230; LM^1 , P1654.231-233; RM^2 , P1654.234-236; upper molar fragment, P1654.237; LM_1 or M_2 , P1654.238-242; RM_1 or M_2 , P1654.243; LM_3 , P1654.244-245.

Description. P^3 (Fig. 2C) parastyle prominent, anterobuccal to paracone; protocone lingual and slightly posterior to paracone; cingulum continuous around base of metacone; in some specimens, low cingulum around protocone base.

M^1 (Fig. 2D) transverse, anteroposteriorly compressed; styler shelf narrow but distinct; hypocone large, low, not completely separated basally from protocone; posterior cingulum short; anterior cingulum low but well defined; para- and metaconule prominent, bulbous.

M^2 (Fig. 2E) more transverse than M^1 , parastyle projecting buccad slightly farther than metastyle.

M_{1-2} (Fig. 2F) trigonid much higher than talonid; talonid longer than trigonid, cristid obliqua straight, low.

M₃ (Fig. 2G) narrower than M₂₋₃, with narrow, elongate talonid.

Discussion. The Swift Current Leptictis is well advanced over Palaeictops in the large size of the P³ parastyle (stronger than in Leptictis acutidens); upper molar transverseness, well defined stylar shelf, stronger hypocone, and more clearly defined anterior cingulum; and lower molar trigonid relatively more elevated.

Leptictis acutidens of the Chadronian compares well in size and in most features of occlusal pattern. L. acutidens M¹ is slightly more transverse, with a slightly larger hypocone; M² has a more oblique buccal border and a larger hypocone; and lower molars are very similar.

Leptictis sp. may belong to a new genus that Novacek is describing, which will include L. acutidens.

Measurements. P³ AP(3), mean 3.30, OR 3.00-3.65; BL(4), mean 2.25, OR 2.05-2.48; HC(1), 2.52. M¹ AP(2), mean 2.52, OR 2.46-2.57; BL(2), mean 3.38, OR 3.31-3.44; HC(1), 1.98. M² AP(3), mean 2.28, OR 2.10-2.45; BL(3), mean 3.43, OR 3.30-3.55; HC(1), 1.52. M₁ or M₂ AP(5), mean 2.67, OR 2.51-2.77; BLtri(6), mean 1.86, OR 1.57-2.18, CV 12.4; BLtal(6), mean 1.83, OR 1.70-2.02, CV 7.1; HC(2), mean 2.41, OR 2.33-2.48. M₃ AP(1), 2.24; BLtri(1), 1.42; BLtal(2), mean 1.40, OR 1.31-1.48.

Family Apatemyidae

Apatemys hendryi Robinson, 1966

Material. RM₃, P1654.246.

Discussion. This tooth (Fig. 2H) is very close to size and occlusal pattern to Badwater material named Apatemys hendryi by Robinson (1966).

West (1973) synonymized A. hendryi with A. bellus. I resurrect A. hendryi because known examples are much smaller than typical A. bellus, and form a satisfactory size group (op. cit., fig. 5). Combination of the species produces an improbably great size range.

Measurements. M_3 AP(1), 1.62; BLtri(1), 0.99; BLta1(1), 0.85; HC(1), 1.08

Family Palaeoryctidae

Didelphodus serus, sp. nov.

Type. Holotype RM^1 , P1654.249.

Material. Holotype and LP^4 , P1654.247-248; RM^2 , P1654.250-251; LM^3 , P1654.252; RP_4 , P1654.253; LM_1 or M_2 , P1654.254; RM_1 or M_2 , P1654.255-256; LM_3 , P1654.257; RM_3 , P1654.258.

Diagnosis. p^4 nearly triangular; M^{1-3} concave posterad, stylar shelf small, parastyle connected weakly to paracone; M^3 anteroposteriorly compressed but not reduced posteriorly; P_4 paraconid reduced; M_{1-3} trigonid anteroposteriorly compressed.

Etymology. Latin serus, late.

Description. p^4 (Fig. 2I) nearly triangular; large paracone set close to buccal border; distinct but small metacone directly posterior to paracone (in second specimen weakly developed and nearly merged with paracone); buccal crown border not deeply excavated; stylar shelf distinct but small; protocone low; paraconule, metaconule distinct but low.

M¹ (Fig. 2J) concave posterad; paracone close to buccal crown border; stylar shelf small; parastyle low, not projecting strongly buccad, connected to anterior base of paracone by low, oblique ridge; metastyle projecting posterobuccad; buccal crown border not deeply excavated; paraconule, metaconule prominent, weakly crescentic.

M² (Fig. 2K) anteroposteriorly compressed relative to M¹; parastyle projecting buccad, connected to paracone by weak, oblique ridge; metastyle weak; stylar shelf in figured specimen weaker than in M¹, in second specimen very small, with para- and metacone nearly reaching buccal border; crown not strongly excavated buccally; para- and metaconule prominent; short, beaded anterior and posterior cingula at protocone base in figured specimen.

M³ (Fig. 2L) compressed anteroposteriorly, not reduced posteriorly; conules very worn but apparently small; otherwise as in M².

P₄ (Fig. 2M) protoconid very high, sharp, recurved posterolingual; paraconid very small and low, at anterolingual corner of crown; posterior cuspid connected by strong ridge to protoconid, forming weak basin.

M₁₋₂ (Fig. 2N) trigonid about twice height of talonid; trigonid anteroposteriorly compressed; protoconid oblique, weakly crescentic; paraconid, metaconid forming transverse ridges, about as high as protoconid; talonid cuspids of equal height; cristid obliqua low, postcristid strong; hypoconulid barely separate from entoconid; posterior cingulum lacking; anterior cingulum weak, short, at anterior protoconid base.

M₃ (Fig. 2O) trigonid slightly less compressed anteroposteriorly; talonid reduced lingually; otherwise as M₁₋₂.

Discussion. Didelphodus serus differs from D. absarokae and D. altidens in occlusal pattern and tooth shape, although it is approximately the same size as its congeners. Posterior concavity of

M^{1-3} , with the protocone somewhat oblique, is a striking difference. Equally distinctive is the relatively small stylar shelf in M^{1-2} of D. serus: in both D. absarokae and D. altidens the para- and metacone are near the middle of the crown, and the stylar shelf is very large, while in D. serus the paracone (in M^1) and metacone (in M^2) are near the buccal border.

In other described Didelphodus, the paracone-parastyle connection is through a high, transverse ridge, and the parastyle projects anterobuccad: in D. serus the connection is low and oblique, and the parastyle does not project anterad.

Paraconid reduction in P_4 , and anteroposterior shortening of the trigonid in M_{1-3} , are perhaps slightly advanced over D. altidens of the Bridgerian, and differ markedly from Wasatchian D. absarokae.

I hesitate to postulate the ancestry of D. serus in another known species, because differences are so great.

Measurements. P_4 AP(2), mean 3.03, OR 2.87-3.18; BL(2), mean 3.10, OR 3.06-3.14; HC(2), mean 2.44, OR 2.22-2.65. M^1 AP(1), 3.27; BL(1), 4.12; HC(1), 2.06. M^2 AP(1), 2.88; BL(2), mean 4.13, OR 3.83-4.42. M^3 AP(1), 2.06; BL(1), 3.87. P_4 AP(1), 2.80; BL(1), 1.70; HC(1), 3.84. M_1 or M_2 AP(3), mean 3.12, OR 2.78-3.67; BLtri(3), mean 2.23, OR 2.09-2.48; BLtal(3), mean 1.99, OR 1.83-2.26; HC(3), mean 2.51, OR 2.11-3.15. M_3 AP(2), mean 2.96, OR 2.90-3.02; BLtri(2), mean 2.28, OR 2.07-2.49; BLtri(2), mean 1.93, OR 1.82-2.04.

Order Dermoptera

Family Plagiomenidae

Thylacaelurus campester, sp. nov.



Fig. 3.A-E, *Thylacaelurus campester* A. RP⁴, P1654.259 (holotype); B, LM¹, P1654.260; C, RI, P1654.263 (lateral aspect); D, RM₁ or M₂, P1654.265; E, RM₃, P1654.267. F-I, *Adapisoricidae*, gen. et sp. indet; F, RM¹, P1654.268; G, LM³, P1654.269; H, RP₄, P1654.270; I, RP₄, P1654.271. J-K, *Erinaceidae*, gen. et sp. indet; J, RM², P1654.274; K, LM₁, P1654.276. L, *Nyctitherium* sp., LM¹ or M², P1654.283. Anterior to left in B, D, E, G-I, L, to right in A, C, F, J, K; buccal to top of page except in C. Scales 1 mm.

Type. Holotype RP⁴, P1654.259.

Material. Holotype and LM¹, P1654.260-261; RM¹, P1654.262; RI₁, P1654.263; LM₁ or M₂ P1654.264; RM₁ or M₂, P1654.265-266; RM₃, P1654.267.

Diagnosis. P⁴ hypocone large, posterior crown border less curved than in I. montanus, metaconule not crescentic, anterolingual cingulum well defined; M¹ hypocone present but weak, anterolingual cingulum well defined, metaconule not crescentic.

Etymology. Latin campester, of the plains.

Description. P⁴ (Fig. 3A) slightly wider than long; hypocone large, connected by oblique ridge to postprotocrista; paraconule small but high, transverse; metaconule large, not crescentic; parastyle, anterobuccal cingulum broken; posterior arm of paracone, anterior arm of metacone strongly connected to buccal styles, separated by deep valley, forming partial dilambdodonty; central basin large, oval; anterolingual cingulum well defined.

M¹ (Fig. 3B) nearly triangular; anterobuccal cingulum present (?); hypocone weak, low; metaconule distinct, oblique, not crescentic; otherwise as P⁴.

Referred incisor (Fig. 3C) four cusped.

M₁ or M₂ (Fig. 3D) two-rooted; trigonid very abbreviated, oblique; para- and metaconid ridged; anterior cingulum rising steeply from protoconid base to paraconid tip; talonid basin very large, broad, completely enclosed; entoconid high, sharp, anteroposteriorly elongate; hypoconulid low, behind transverse postcristid; posterior cingulum short, dropping sharply buccad from hypoconulid.

M₃ (Fig. 3E) single-rooted; trigonid more compressed, oblique than in M₁₋₂; talonid less expanded buccolingually, only slightly broader than trigonid; hypoconulid immediately posterobuccal to entoconid, projecting posterad.

Discussion. I reinterpret tooth positions in the holotype of Thylacaelurus montanus (Russell, 1954a, fig. 2; pl. 2. fig. 2) as P³-M¹. If my assignment is correct, P³⁻⁴ of Thylacaelurus were larger than the molars, as in Worlandia (Bown and Rose, 1979, p. 100); the zygomatic arch arose near the posterior end of P⁴ as in Plagiomene (Matthew and Granger, 1918, fig. 27); and the peculiar P³ of Thylacaelurus is at least roughly comparable to P³ in Plagiomene (Rose and Simons, 1977, fig. 2E).

P³ of T. montanus is worn and poorly preserved. In contrast to Plagiomene, the protocone is elongate and sharply inflected anterolingual, the parastyle appears to be lacking, and the para- and metaconule are lacking (or obliterated by wear?). The P³ metacone of T. montanus is broken, but was apparently larger than in Plagiomene. P⁴ was fully molariform, and P⁴-M¹ patterns are at least reminiscent of other plagiomenids.

The dental formula of Thylacaelurus is uncertain: Russell (1954a, p. 97) postulated that the last molar preserved in the holotype (M¹) might indeed be the last element in the cheek-tooth series. M¹ is reduced posterolingually and is set obliquely in the maxilla, and the tooth row is markedly concave inward, all suggesting an abbreviated dental series. One M¹ of T. campester (P1654.260) has a small wear facet near its posterobuccal corner, indicating that M² was present. M³ was probably absent or extremely reduced.

Swift Current lower molars are the first that have been assigned to the genus. Trigonids are even more oblique and anteroposteriorly compressed than in other plagiomenids, and talonid basins are much larger. Entoconids are high and anteroposteriorly elongate, and M₁₋₂

hypoconulids are isolated behind the postcristids, both characteristics of plagiomenids. Posterior crown borders in M_{1-2} are nearly transverse, as in Worlandia but not in Plagiomene.

Lower teeth show features uniting Thylacaelurus with plagiomenids, as well as features peculiar to the genus. My designation of a tooth as M_3 is provisional, considering the uncertainty of M^3 's presence; the tooth is an ultimate molar, and it is unusual in being single-rooted.

Thylacaelurus is probably closer to the Worlandiinae than to the Plagiomeninae, resembling the worlandiines in: p^{3-4} larger than molars; conules in p^4-M^1 somewhat reduced and not strongly crescentic; central basins of p^4-M^1 and talonid basins of lower molars considerably enlarged; and posterior borders of lower molars less oblique than in typical plagiomenines.

The holotype of T. montanus is from the Kishenehn Formation of British Columbia, and is Oligocene, but of uncertain correlation. Uintan material from Swift Current is considerably older, and shows differences sufficient to erect a separate species. p^4 from Uintan Badwater deposits (Krishtalka and Setoguchi, 1977, p. 94) are slightly smaller, with more prominent metaconule and hypocone, and more buccal paracone, but are probably also referable to T. campester.

Measurements. p^4 AP(1), 1.83; BL(1), 2.31. M^1 AP(3), mean 1.60, OR 1.59-1.61; BL(3), mean 2.08, OR 2.07-2.09; HC at protocone(1), 1.45. M_1 or M_2 AP(2) mean 1.76, OR 1.65-1.87; BLtri(2), mean 1.27, OR 1.19-1.35; BLtal(3), mean 1.49, OR 1.35-1.63. M_3 AP(1), 1.77; BLtri(1), 1.15; BLtal(1), 1.25.

Order Insectivora

Family Adapisoricidae

Adapisoricidae, gen. et sp. indet.

Material. RM¹, P1654.268; LM³, P1654.269; RP₄, P1654.270-271.

Description. M¹ (Fig. 3F) metastyle projecting strongly buccad, slightly posterad; parastyle apparently projecting weakly anterad; stylar shelf poorly preserved, apparently moderately developed, not sharply concave; para- and metaconule large, rounded, anterior arms reaching parastyle, anterolingual base of metacone; hypocone large, lower than protocone, separated from protocone by shallow valley; posterior cingulum complete, strong, from hypocone to metastyle; anterior cingulum absent.

M³ (Fig. 3G) paracone triangular, sharp; metacone low, oblique, at posterobuccal corner of crown; parastyle projecting anterobuccad; paraconule large but very low, weak; metaconule, posterior cingulum absent.

P₄ (Figs. 3H,I) trigonid bulbous, with large protoconid concave anterolingually; paraconid, metaconid reduced to sloping ridges; basal cuspule at anterolingual border of crown; talonid bulbous, sloping buccad, without distinct cusps.

Discussion. This material represents an undescribed genus and species, distinct from all known forms in M¹ lack of marked buccal concavity, with complete, strong posterior cingulum reaching from hypocone to metastyle; and P₄ reduction of paraconid and metaconid to sloping ridges, basal cuspule at anterolingual border, and apparent lack of talonid cusps.

No known genus shares P_4 morphology of the Swift Current form. Sespedectes and Proterixoides of the California later Eocene have somewhat similar upper molars, with complete, strong posterior cingula, but higher hypocones, sharply concave buccal borders, and more prominent parastyles.

Although the Swift Current adapisoricid is clearly different from described genera, I prefer to await the discovery of better material before naming it.

Measurements. M^3 AP(1), 1.23; BL(1), 1.65. P_4 AP(2), mean 1.88, OR 1.80-1.96; BL(2), mean 1.47, OR 1.25-1.69; HC(1), 2.28.

Family Erinaceidae

Erinaceidae, gen. et sp. indet.

Material. RM^1 , P1654.272; LM^2 , P1654.273; RM^2 , P1654.274; upper molar fragment, P1654.275; RP_4 , P1589.1; LM_1 , P1654.276-277; RM_1 , P1654.278; RM_2 , P1654.279; RM_3 , P1654.280; lower molar fragments, P1654.281-282.

Discussion. This material appears to represent the same species of erinaceid that Krishtalka and Setoguchi (1977, p. 80) identified from Badwater. They noted that better specimens from elsewhere were being described (Krishtalka and McKenna, in prep.).

Measurements. M^1 AP(1), 1.72. M^2 BL(1), 2.27. P_4 AP(1), 1.51; BL(1), 1.21. M_1 AP(3), mean 2.17, OR 1.97-2.41; BLtri(2), mean 1.55, OR 1.40-1.70; BLtal(2), mean 1.70, OR 1.43-1.96. M_2 AP(1), 1.89; BLtri(1), 1.30; BLtal(1), 1.36. M_3 AP(1), 1.61; BLtri(1), 0.98; BLtal(1), 0.93; HC(1), 1.00.

Family Nyctitheriidae

Nyctitherium sp.

Material. LM¹ or M², P1654.283.

Discussion. A fragmentary upper molar (Fig. 3L) is close in size and occlusal features to Nyctitherium christopherei from Badwater (Krishtalka and Setoguchi, 1977, p. 80). Particular points of resemblance are large size and deeply concave buccal border.

Family Geolabididae

Centetodon aztecus Lillegraven et al., 1981.

Material. RM¹, P1654.284; LM², P1654.285; RM², P1654.286; RM³, P1654.287; LP₂, P1654.288; RP₃, P1654.289-290; LP₄, P1654.291; RP₄, P1654.292-297; LM₁, P1654.298-300; LM₂, P1654.301-304; RM₂, P1654.305; L mandible with M₂₋₃, P1654.306; RM₃, P1654.307; lower molar fragments, P1654.308-310.

Discussion. The Swift Current sample is identical with Centetodon aztecus of the California later Eocene (Lillegraven et al., 1981), except for a stronger anterolingual cingulum in upper molars (Fig. 4B).

Lingual roots in upper molars (Fig. 4A) are fused ventrally, distinctly separated dorsally, and thus agree with a critical part of the diagnosis of C. aztecus.

Lower molar occlusal patterns (Fig. 4C) are similar to those of various Centetodon species. P₄ (not shown) agrees with C. aztecus in restriction of the buccal cingulum to the paraconid base. P₄ and M₃ are also rather long in relation to M₁₋₂, as in C. aztecus.

Fig. 4. A-C, Centetodon aztecus; A, LM², P1654.285 (lingual aspect); B, RM², P1654.286; C, L mandible with M₂₋₃, P1654.306. D-G, Wallia scalopidens; D, LM¹, P1654.311 (holotype); E, LM², P1654.313; F, LM³, P1654.314; G, L mandibular fragment with M₂, P1654.316. H, Domnina sp., R mandibular fragment with M₁₋₂, P1589.2. I, Soricidae, sp. A, LM₂, P1654.320. Anterior to left in A, D-F, H, to right in B, C, G, I; buccal to top of page except in A. Scales 1 mm.



Measurements. M^2 AP(1), 1.58; BL(1), 2.49; HC(1), 0.97. P_2 BL(1), 0.53. P_3 AP(2), mean 1.21, OR 1.07-1.35; BL(2), mean 0.63, OR 0.60-0.66. P_4 AP(3), mean 1.60, OR 1.42-1.80; BL(5), mean 0.88, OR 0.85-0.90, CV 2.3; HC(1), 2.06. M_1 AP(2), mean 1.94, OR 1.93-1.94; BLtri(2), mean 1.21, OR 1.19-1.23; BLtal(2), mean 1.09, OR 1.03-1.15. M_2 AP(6), mean 1.66, OR 1.50-1.86, CV 7.8; BLtri(6), mean 1.10, OR 0.96-1.16, CV 7.3; BLtal(6), mean 0.98, OR 0.91-1.02, CV 4.1; HC(1), 1.80. M_3 AP(2), mean 1.70, OR 1.56-1.84; BLtri(2), mean 0.98, OR 0.94-1.02; BLtal(2), mean 0.80, OR 0.78-0.82.

Family Proscalopidae

Wallia, gen. nov.

Type species. Wallia scalopidens, sp. nov.

Diagnosis. Molars strongly dilambdodont; upper molars with oblique postprotocrista, indistinct para- and metaconule, large, low hypocone except in M^3 , strong preprotocrista forming anterior shelf reaching to strongly inflected parastyle; lower molars with anteroposteriorly compressed, oblique trigonid and talonid, continuous, strong anterior, buccal and posterior cingula, hypoconulid as high as postcristid.

Included species. Type species only.

Etymology. Named in honor of Mr. Ed Wall, owner of the Swift Current Creek Locality.

Wallia scalopidens, sp. nov.

Type. Holotype LM^1 , P1654.311.

Material. Holotype and RM^1 , P1654.312; LM^2 , P1654.313; LM^3 , P1654.314; RM^3 , P1654.315; L mandibular fragment with M_2 , P1654.316.

Diagnosis. Within generic diagnosis.

Etymology. Greek skalops, mole; Latin dens, tooth.

Description. Upper molars strongly dilambdodont; M^{1-2} paracone, metacone sharply crescentic, deeply excavated buccally; mesostyle connected to para- and metacone, ectoloph forming a complete W; parastyle inflected anterolinguad, metastyle distinct but not inflected; protocone sharp, broadly crescentic, nearly as high as paracone; para- and metaconule indistinct; postprotocrista oblique, reaching metastyle; preprotocrista transverse, forming broad shelf reaching parastyle; hypocone large but low, separated from postprotocrista by shallow valley; anterior cingulum low, weak, at anterior protocone base.

M^1 (Fig. 4D) longer buccally than lingually; paracone closer to buccal border than metacone; buccal border notched at paracone. M^2 (Fig. 4E) more transverse than M^1 ; para- and metacone nearly equidistant from buccal border; buccal border notched at both para- and metacone.

M^3 (Fig. 4F) transverse, triangular, crown reduced posteriorly; hypocone absent; para- and metaconule apparently absent; parastyle strong, curved linguad; buccal border notched at paracone; paracone deeply crescentic, situated near middle of crown.

Mandible shallow, approximately upright-oval in cross-section, narrower than M_2 ; mental foramina not visible; ascending ramus rising sharply behind M_3 .

M_2 (Fig. 4G) parallelogram-shaped; trigonid, talonid anteroposteriorly compressed, oblique; cristid obliqua connecting near top of metaconid, giving strong W-shape to lophids; hypoconulid as high as postcristid; anterior, buccal, posterior cingula strong, continuous.

Discussion. Wallia scalopidens is close to the basal stock of the Proscalopidae (Barnoski, 1981).

W. scalopidens resembles the earliest described proscalopid dentitions (Oligoscalops galbreathi of the Orellan: Reed, 1961) not only in the prominent W-shape of lophs and lophids, with deep buccal excavation of the para-and metacone, and strong connection of the cristid obliqua with the metaconid tip; but also in upper molar shapes, particularly M^1 and M^3 ; anteroposteriorly compressed, oblique lophids and strong cingula in lower molars; and mandibular shape and depth. Notching of the buccal border at the para-and metacone also provides a resemblance to proscalopids.

Other characteristics resemble ancestral forms, which were probably Leptacodon-like (Robinson, 1968a; Sigé et al., 1977). A low but prominent hypocone in M^{1-2} , isolated from the protocone; preprotocrista reaching the tip of the sharply-inflected parastyle and forming a broad shelf anteriorly; postprotocrista oblique rather than anteroposterior as in proscalopids; and lower molar hypoconulid as high as the postcristid, all resemble Leptacodon (Krishtalka, 1976).

Indistinct para-and metaconules in M^{1-2} are a peculiarity of Wallia scalopidens. In Leptacodon, conules are distinct and moderately to strongly crescentic, paraconule larger and higher than metaconule; and in Oligoscalops the paraconule and metaconule are distinct and bulbous, with the metaconule forming a prominent cusp at the posterolingual corner of the crown. Thus W. scalopidens may not be the particular species from which later proscalopids evolved.

Strong dilambdodonty in upper molars is also seen in didelphid marsupials, soricid insectivores, and chiropterans. Didelphids (Peratherium) have less deeply excavated buccal cusps, styler shelf prominent buccal to the ectoloph, and no hypocone. Soricids show less deeply excavated buccal cusps and a low, cingular, obliquely compressed hypocone that connects directly to the postprotocrista.

Separation of Wallia from the Chiroptera is more difficult. Characteristics discussed by Sigé et al. (1977) eliminate the present material from the rhinolophids and emballonurids (ectoloph with more

divergent crests); the kerivoulids (thick cingula, postprotocrista not reaching posterior crown border); and the vespertilionoids, s.s. (parastyle not massive, mesostyle never doubled, usually continuous cingula, posterior cingulum well developed). Palaeochiropterygoids usually have no hypocone, show thick and often continuous cingula, and have less divergent protocone arms, but M^1 of Wallia is disconcertingly similar to Cecilionycteris (Sigé and Russell, 1980, pl. 7, fig. 4)), except for details of the hypocone, weakness of the anterior cingulum, and lack of the posterior cingulum. If only the upper dentition of Wallia were known, it would be difficult to exclude it from the Palaeochiropterygoidea.

The referred lower molar of W. scalopidens is unlike any chiropteran molar in anteroposterior compression and obliqueness of lophids, and completion of the W-pattern by connection of the cristid obliqua with the metaconid tip. In some modern Chiroptera, the cristid obliqua points toward the metaconid, but never makes the strong, high connection characteristic of Wallia and the moles.

Leptacodon presents similarities in the lower dentition that are indicative of possible ancestry. Although the trigonid of Leptacodon is much higher than the talonid, lophids are somewhat compressed, oblique, and buccally acute, and the cristid obliqua points toward the metaconid, often sending a weak ridge up the posterior face of the metaconid.

A parallel group includes the nyctithere Pontifactor (West, 1974), whose known range is mid-Clarkforkian (Rose, 1981) to late Bridgerian (type material). Upper molars of Pontifactor have more conical, weakly excavated buccal cusps and strong, crescentic para- and metaconule, and the only known lower molars (Krishtalka, 1976, p. 23) have somewhat compressed and oblique lophids, but lack the strong cristid obliqua-metaconid connection and strong buccal cingulum, and retain considerable discrepancy between trigonid and talonid heights. I regard Wallia and Pontifactor as somewhat parallel developments from similar ancestors, rather than as close relatives.

Another parallel form is Eotalpa (Sigé et al., 1977) of the basal Oligocene, Isle of Wight. Lower molars of E. anglica are not known. M^{1-2} have a narrower and less deeply excavated ectoloph than in Wallia, styler accessory cusps, protocone set farther posterad than paracone, smaller hypocone, expanded conules, and more anteroposterior postprotocrista. Familial separation of Eotalpa and Wallia is arbitrary, known Talpidae being restricted to the Old World until the Mid-Miocene, and Proscalopidae remaining endemic to North America throughout their range. Postcranial elements are unknown for both Eotalpa and Wallia. Dental differences between Eotalpa and Wallia are appropriate for parallel lineages.

In summary, Wallia scalopidens is an early proscalopid, represents in most features the transition from a Leptacodon-like ancestor to later proscalopids (e.g., Oligoscalops), and parallels the nyctitheriid Pontifactor and the talpid Eotalpa, both of which were descended from similar Leptacodon-like ancestors.

Measurements. M^1 AP(2), mean 1.61, OR 1.47-1.75; BL(2), mean 1.99, OR 1.98-1.99; HC at metacone (2), mean 1.10, OR 1.05-1.15. M^2 AP(1), 1.56; BL(1), 2.25. M^3 AP(1), 1.30; BL(1), 1.95. M_2 AP(1), 1.74; BLtri(1), 1.13; BLtal(1), 1.12; HC(1), 1.32.

Family Soricidae

Domnina sp.

Material. R mandibular fragment with M_{1-2} , P1589.2.

Description. M_{1-2} (Fig. 4H) with strong, continuous anterior, buccal, posterior cingula, stronger in M_2 than M_1 . Cristid obliqua joining trigonid lingual to protoconid. Paraconid-metaconid valley blocked by lingual cingulum, very strong in M_1 and weaker in M_2 .

Discussion. In visible details, this specimen corresponds well with Domnina gradata. It is somewhat larger than Orellan D. gradata (Cope, 1884, p. 811), and much larger than D. cf. D. gradata from Badwater (Krishtalka and Setoguchi, 1977, p. 91).

Because the Swift Current specimen is poorly preserved, and differs in both size and age from well-founded species of Domnina, I prefer to make only generic reference.

Measurements. M_1 AP(1), 2.83; BLtri(1), 1.91; BLtal(1), 1.91. M_2 AP(1), 2.76; BLtri(1), 1.80; BLtal(1), 1.71.

Soricidae, sp. A

Material. LM_1 , P1654.317-318; RM_1 , P1654.319; L mandibular fragment with M_2 , P1654.320; RM_2 , P1654.321; LM_3 , P1654.322; lower molar fragments, P1654.323-328.

Discussion. Lower molars (Fig. 4I) are not distinguishable from the Badwater Soricid sp. A (Krishtalka and Setoguchi, 1977), and in the specimen illustrated the cristid obliqua joins the trigonid beneath the protoconid, forming a very shallow buccal valley as in the Badwater material.

Orientation of the cristid obliqua, and strength of the buccal and posterior cingula are variable in the Swift Current sample, and it is possible that more than one small soricid species is represented.

Measurements. M_1 AP(2), mean 1.59, OR 1.58-1.60; BLtri(3), mean 1.04, OR 0.93-1.18; BLtal(2), mean 1.07, OR 1.06-1.07; HC(1), 1.30. M_2 AP(1), 1.79; BLtri(2), mean 1.06, OR 1.00-1.12; BLtal(2), mean 1.16, OR 1.10-1.21; HC(1), 1.25. M_3 AP(1), 1.41; BLtri(1), 0.97; BLtal(1), 0.75; HC(1), 1.33.

Family Apternodontidae

Oligoryctes sp.

Material. LM¹, P1654.329; RM², P1654.330; LM₁ or M₂, P1654.331; RM₁ or M₂, P1654.332.

Discussion. This material is too poor for specific determination. Three specimens are comparable in size and occlusal pattern to the Badwater Oligoryctes: M¹; M² (AP, 1.16; BL, 1.47; HC at protocone, 1.01); and RM₁ or M₂ (AP, 1.04; BL, 1.14; HC, 1.70). LM₁ or M₂ is considerably larger (AP, 1.33; BL, 1.27; HC, 1.83) and different in occlusal shape.

Family incertae sedis

Insectivora, incertae sedis

Material. R mandibular fragment with P₄-M₁, P1654.333.

Description. P₄ longer than M₁ (Fig. 5D); P₄ trigonid high, elongate; protoconid, metaconid set very close together; paraconid very low, directed well anterad; talonid slightly broader than trigonid, posterobuccal corner apparently projecting obliquely; cristid obliqua directed toward metaconid.

M₁ trigonid relatively less high than in P₄, roughly triangular, longer than talonid; protoconid, metaconid set close together, protoconid slightly higher; paraconid transverse; trigonid basin shallow; cristid obliqua joining middle of trigonid; hypoconulid nearly as large, high as entoconid, projecting posterad posterobuccal to entoconid; hypoconid, posterior cingulum projecting posterobuccad.

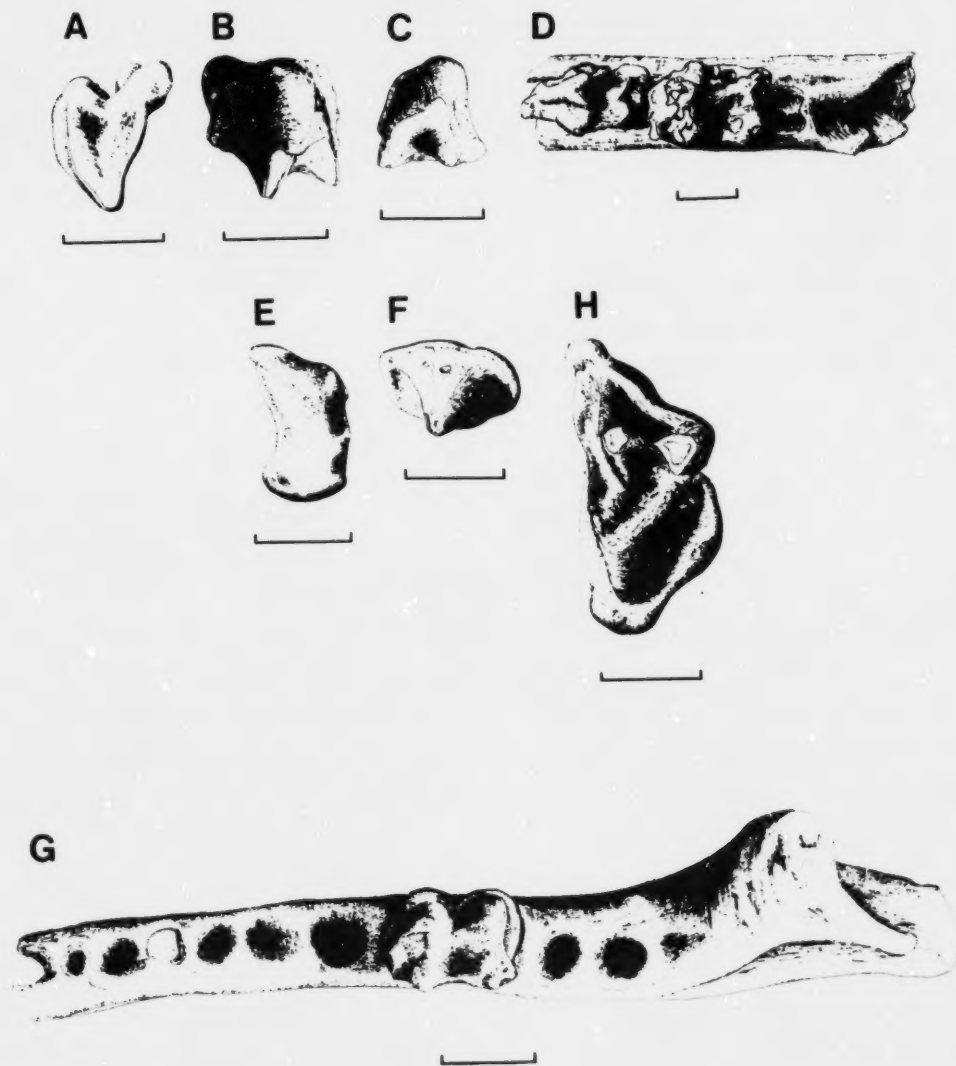


Fig. 5. A-C, *Oligoryctes* sp.; A, RM^2 , P1654.330; B, LM_1 or M_2 , P1654.331; C, RM_1 or M_2 , P1654.332. D, Insectivora, *incertae sedis*, R mandibular fragment with P_4-M_1 , P1654.333. E-G, Chiroptera, sp. 1; E, RP^4 , P1654.334; F, LP_4 , P1654.336; G, R mandibular fragment with M_2 , P1654.337. H, Chiroptera, sp. 2, LM^3 , P1654.342. Anterior to left in C, D, G, H, to right in A, B, E, F. Scales 1 mm.

Discussion. This poorly preserved specimen does not show close similarity to any described group.

There is some similarity to the Nyctitheriidae, and teeth of P1654.333 agree in size with the upper molar fragment assigned to Nyctitherium. Positions and orientations of the hypoconid and posterior cingulum are reminiscent of Nyctitherium, and relative trigonid-talonid heights are similar. But trigonids in P_4-M_1 are much longer than in known nyctitheres, the cristid obliqua in M_1 is less transverse, and in Nyctitherium and Pontifactor trigonids are anteroposteriorly reduced and metaconids are transverse.

Interesting and perhaps meaningful similarities to Aethomylos (Novacek, 1976, p. 40) include the long, rounded trigonid of M_1 , bulbous, oblique metaconid, and shallow trigonid basin, with similar trigonid and talonid heights in M_1 . Aethomylos, also incertae sedis within the Insectivora, has more buccally rounded M_1 lophids, cristid obliqua directed toward the protoconid, and lacks the posterior cingulum and posterobuccal orientation of the hypoconid.

Order Chiroptera

Suborder Microchiroptera

Superfamily Vespertilionoidea

Family incertae sedis

Chiroptera, sp. 1

Material. RP^4 , P1654.334-335; LP_4 , P1654.336; R mandibular fragment with M_2 , P1654.337; RM_1 or M_2 , P1654.338; lower molar fragments, P1654.339-341.

Description. P^4 (Fig. 5E) three-rooted; crown roughly rectangular, long axis buccolingual; paracone high, sharp; metacone a strong ridge projecting posterobuccad from paracone; protocone a low, transverse

ridge connected to paracone base; hypocone very low but distinct, separated from paracone, metacone by rounded, plunging valley; anterobuccal cingulum from protocone base to metacone base, including low parastyle.

Mandible (Fig. 5G) indicating presence of enlarged canine, single-rooted P_{2-3} , double-rooted P_4-M_3 ; alveolus for P_3 larger than that for P_2 ; large mental foramen beneath P_2 , anterior end of P_3 ; mental process beneath P_2 .

P_4 (Fig. 5F) protoconid high, occupying most of crown; metaconid absent; talonid not basined; low cingula surrounding crown; paraconid small, low.

M_2 (Fig. 5G) metaconid, paraconid subequal, anteroposteriorly compressed, nearly as high as protoconid; trigonid cusps well separated; trigonid valley slightly oblique, blocked by low lingual cingulum; hypoconid, entoconid of nearly equal height, connected by low, complete, transverse postcristid; hypoconulid connected to entoconid and postcristid, nearly posterior to entoconid; cristid obliqua joining middle of trigonid; anterior, buccal, posterior cingula strong, continuous.

Discussion. This material is distinctly chiropteran, and elements are of appropriate size to belong to a single taxon.

Among living bats, there is general similarity to members of the family Vespertilionidae. Lasiurus borealis has a comparable P_4^4 , with the fossil tooth slightly more transverse, with larger protocone. L. borealis has a single-rooted P_3 and reduced but double-rooted P_4 ; many other vespertilionids, including Myotis, retain a small, single-rooted P_2 . In L. borealis lower molars, the paraconid and metaconid are high, though not as high as in the fossil, and are well separated from the protoconid.

Posterior cusp connections in M_2 are intermediate between nyctalodonty and myotodonty (Menu and Sigé, 1971). The postcristid is transverse and connects the hypoconid and entoconid, but the hypoconulid is connected to both the postcristid and entoconid. This condition is reminiscent of the echioproterans Palaeochiropteryx (Russell and Sigé, 1970) and Cecilonycteris (Sigé and Russell, 1980), but the postcristid is more transverse than in either genus, and the entoconid connection is stronger. I suspect that incipient myotodonty is represented.

Myotodonty appears to be a more advanced evolutionary grade than nyctalodonty, and its presence excludes the Swift Current material from the nyctalodont superfamily Rhinolophoidea, and may indicate an advance over the echioproterans.

Though it retains three lower premolars, this Swift Current bat is advanced over the middle Eocene Hassianycteris (Smith and Storch, 1981) in reduction of P_3 roots to one. Reduction of P_3 roots and loss of the P_4 metaconid appear to distinguish this bat from the Echioprotera as well.

Measurements. P^4 AP(1), 1.02; BL(1), 1.46; HC(2), mean 1.40, OR 1.34-1.46. P_4 AP(1), 1.40; BL(1), 0.93; HC(1), 1.90. M_2 AP(1), 1.53; BLtri(1), 1.09, BLtal(1), 0.98, HC(1), 1.05. M_1 or M_2 AP(1), 1.45; BLtri(1), 0.82; BLtal(1), 0.96; HC(1), 1.23.

Chiroptera, sp. 2

Material. LM³, P1654.342.

Description. M^3 (Fig. 5H) transverse; paracone higher than protocone, sending long, sharp spur buccad; parastyle curved anterolingual, joining lingually with preprotocrista; paraconule close to protocone; metaconule prominent, lingual to metacone; styler shelf moderately expanded, with low buccal cingulum from parastyle to buccal wall of

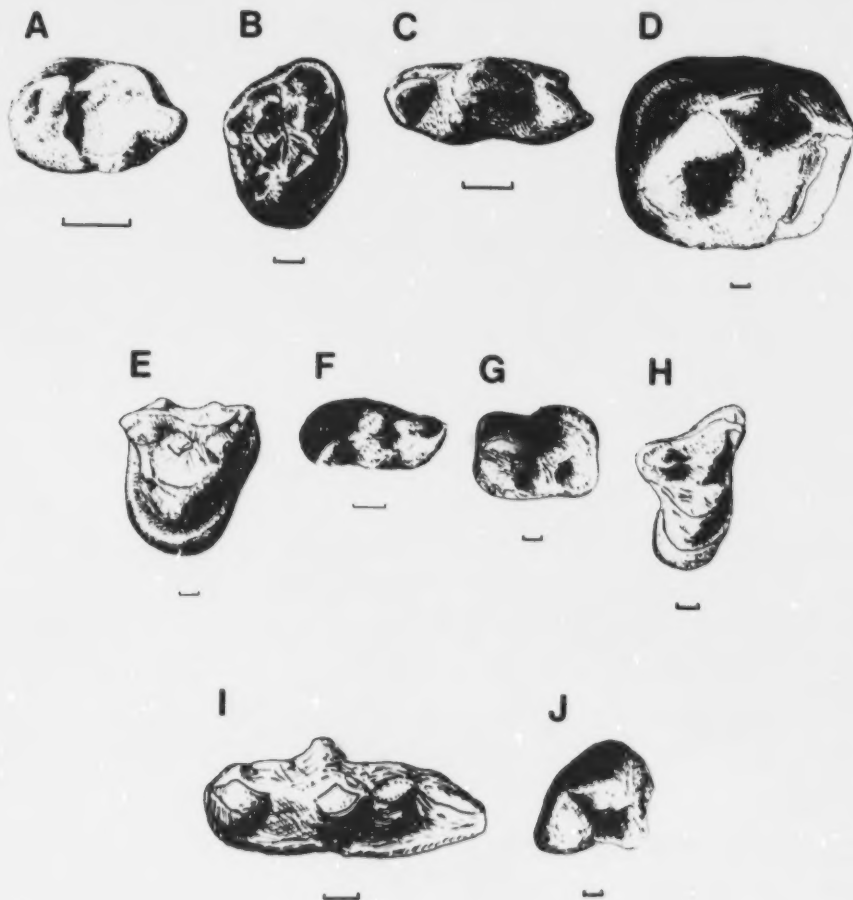


Fig. 6. A, Omomyidae, sp. 1, RM_3 , P1654.343. B, Omomyidae, sp. 2, RM^3 , P1654.470. C, *Viverravus* sp., LM_1 , P1654.345. D, *Prodaphoenus* cf. *P. scotti*, RM_2 , P1578.1. E-G, Caniformia, sp. 1; E, RM^1 , P1654.346; F, LP_4 , P1654.347; G, LM_2 , P1654.348. H-J, Caniformia, sp. 2; H, RM^1 , P1654.350; I, RP_4 , P1654.352; J, RM_1 , P1654.353. Anterior to left in A, D, H-J to right in B, C, E-G; buccal to top of page. Scales 1 mm.

metacone; anterior cingulum traversing half crown width, continuous with strongly expanded posterior cingulum bearing strong cuspule posterior to protocone.

Discussion. A continuous cingulum around the lingual crown border appears to ally this specimen with the Chiroptera.

The specimen at hand represents a much larger form than Chiroptera, sp. 1.

Measurements. M^3 AP(1), 1.43; BL(1), 3.06; HC at protocone(1), 0.81.

Order Primates

Family Omomyidae

Omomyidae, sp. 1

Material. RM_3 , P1654.343-344.

Discussion. M_3 (Fig. 6A) is similar in size and occlusal pattern to Chumashius balchi, later Eocene of California (Gazin, 1958a, p. 63). It has a slightly more distinct entoconid than the holotype, set more directly opposite the hypoconid, and has slightly stronger buccal cingula.

Close as this material is to Chumashius, I am prepared to identify it only as a small omomyid. M_3 is variable in later Eocene samples, and I prefer to postpone more specific reference until more material is available.

Measurements. RM^3 AP(2), mean 2.52, OR 2.42-2.62; BLtri(2), mean 1.62 OR 1.58-1.66; BLtal(2), mean 1.62, OR 1.55-1.68; HC(2), mean 0.99, OR 0.98-0.99

Omomyidae, sp. 2

Material. RM³, P1654.470.

Description. Crown reduced posterad (Fig. 6B); enamel of central basin, posterior area heavily rugose; cingula continuous except at protocone, metacone; para-and metaconule prominent, sharp, crescentic; para-and metacone separated by sharp, narrow valley; parastyle, metastyle very weak; mesostyle possibly represented by cuspule on buccal cingulum.

Discussion. This tooth represents a large omomyid, about the size of Ourayia uintensis (Gazin, 1958a, p. 72). The upper dentition of Ourayia is not known (Krishtalka, 1978), and conclusive identification cannot be made, but lower molars in the holotype of O. uintensis have deep, heavily rugose basins as in the Swift Current specimen.

Whatever the correct identification of this specimen may be, it does not resemble the upper molars previously assigned to Ourayia and now referred to Macrotarsius (Krishtalka, 1978). Those specimens are relatively quadrate, with strong buccal styles and low, blunt conules.

Measurements. M³ AP(1), 4.0; BL(1), 4.8; HC(1), 2.6.

Order Carnivora
Suborder Feliformia
Family Viverravidae

Viverravus sp.

Material. LM₁, P1654.345.

Description. M₁ (Fig. 6C) elongate, narrow; protoconid elongate, high, not markedly recurved posterad; paraconid oblique, nearly half as high as protoconid, nearly horizontal, separated from protoconid by deep carnassial notch; metaconid lower than paraconid but higher than talonid, distinct, set farther posterad than protoconid; talonid narrow, with high, trenchant ridge from hypoconid to base of protoconid; talonid weakly basined lingually; low cuspule at anterior base of paraconid; buccal cingulum weak; hypoconulid indistinct at occlusal surface, but projecting strongly posterad from middle of talonid.

Discussion. The elongate trigonid of the Swift Current specimen, with distinct metaconid, somewhat elongate and oblique paraconid, and narrow talonid, suggest Viverravus.

The species represented is far advanced over described Viverravus. V. gracilis of the late Bridgerian has a distinctly basined talonid, larger metaconid nearly even with the protoconid, and less elongate trigonid. Uintan representatives have not been described, and the Swift Current form is clearly a new species.

Swift Current Viverravus could be ancestral to Oligocene Palaeogale. Palaeogale has a more elongate trigonid, with bladelike, more anteroposterior paraconid; no metaconid; trenchant, unbasined talonid; and protoconid markedly recurved posterad.

Descent of Palaeogale from Viverravus was postulated by Hunt (1974), and the hypothesis was analyzed in detail by Flynn and Galiano (1982). The Swift Current specimen, which is very advanced for Viverravus but does not quite reach the evolutionary grade of Palaeogale, adds dental evidence in favor of such a relationship.

Flynn and Galiano (op. cit.) have assigned Viverravus to the family Viverravidae, infraorder Aeluroidea, suborder Feliformia, rather than to its customary position among the Miacidae. I follow them in their assignment.

Suborder Caniformia

Family incertae sedis

Prodaphoenus cf. P. scotti Wortman and Matthew, 1899

Material. RM₂, P1578.1.

Description. M₂ (Fig. 6D) large, low-crowned; talonid barely lower than trigonid; paraconid, metaconid weak, nearly submerged in blunt, beaded trigonid cristids; beaded, massive anterior cingulum forming shelf at anterior base of protoconid; talonid apparently abbreviated; cristid obliqua connecting at crest of postprotocristid, between protoconid and metaconid.

Discussion. I recognize Prodaphoenus as a genus distinct from Uintacyon in its more massive, low-crowned cheek teeth with blunt, beaded ridges and cingula. P. scotti is the only described species, based on type material from the Myton beds, basal Uinta C of Utah. A mandible from the Lapoint Member, Duchesne River Formation of Utah (Emry, 1981, p. 565) has a large, unreduced M₂, and a fragment of M₁ talonid has blunt, beaded cristids and a very shallow basin; this specimen may well be referable to Prodaphoenus, but is larger than P. scotti.

M₂ of P. scotti is not present in the hypodigm, but alveoli for M₂ in paratype AMNH 2510 indicate an unreduced tooth as large as the Swift Current specimen. The M₁ talonid in the paratype, and M² of the holotype, parallel the Swift Current specimen in low crown height and blunt, beaded cingula and ridges.

Uintacyon shows a trend toward massive, low-crowned dentition, but never duplicates the blunt, beaded cingula and ridges of Prodaphoenus, or the extremes of size and brachydonty of P. scotti. M_2 of Uintacyon major, Bridger C of Wyoming, is smaller and relatively higher-crowned, with a more squared anterolingual corner, wider talonid, and smaller, unbeaded anterolingual cingulum. Trigonid cuspids are distinct in M_2 of U. major, and the trigonid basin is open lingually.

Wortman and Matthew (1899, p. 115) proposed Prodaphoenus as an ancestor of Oligocene Daphoenus, but the extreme massiveness and brachydonty of the dentition in P. scotti rule out such a relationship. Prodaphoenus was probably a specialized descendant of Uintacyon that did not give rise to later genera.

Prodaphoenus is a member of the Caniformia, because of the extreme reduction of the P^4 parastyle and protocone, and complete lingual cingula on upper molars (Flynn and Galiano, 1982, p. 50).

Assignment to a family is problematical. Abandonment of the wastebasket family Miacidae was recommended by Flynn and Galiano (op. cit.), but no suitable family names are available for many genera. Quercygale, Tapocyon, and Uintacyon are apparently closely related (op. cit., p. 57), and Prodaphoenus is probably a member of the same caniform group.

Measurements. M_2 BLtri(1), 9.0; HC(1), 3.0

Caniformia, sp. 1

Material. RM^1 , P1654.346; LP_4 , P1654.347; LM_2 , P1654.348; RM_2 , NMC 9165, P1654.349.

Description. M^1 (Fig. 6E) with low, broadly crescentic protocone; paraconule prominent, not crescentic, with at least two cuspsules anterobuccal to it; metaconule somewhat enlarged, immediately

posterolingual to metacone; lingual cingulum complete from paracone to metastyle, strong but forming only small shelf posterolingual to protocone.

P₄ (Fig. 6F) nearly oval; paraconid small or absent; metaconid distinct, near posterior base of protoconid; posterior heel cuspid low; cingula very weak.

M₂ (Fig. 6G) of moderate crown height; trigonid markedly higher than talonid; trigonid cuspids distinct, basin open linguallly; paraconid, metaconid ridged, transverse; metaconid as high as protoconid; anterobuccal cingulum forming distinct shelf of moderate size; talonid slightly reduced posterolingually, as long as trigonid; entoconid ridged, oblique.

Discussion. This material shows resemblances to Vulpavus palustris in M¹ lingual shape and cingulum strength; P₄ crown height, shape, and metaconid-posterior cuspid strength; and M₂ shape and pattern. Although the material is not complete enough for specific reference, it does not represent V. palustris itself, because of the large M¹ conules in the Swift Current specimen, and many minor differences.

M₂ is also similar to Wasatchian Vassacyon in pattern and relative crown height.

This suite of specimens is distinct from Oodectes and from the Quercygale-Uintacyon-Tapocyon-Prodaphoenus group, and is evidently closer to Vulpavus and Vassacyon than to Procynodictis or to species of Miacis or daphoenine amphicyonids with which I have made comparisons.

Measurements. P₄ BL(1), 2.2., M₂, NMC 9165, AP, 6.6; BLtri, 4.3; BLtal, 4.1. M₂, P1654.348, AP, 5.6; BLtri, 4.2; BLtal, 3.9; HC, 3.0. M₂, P1654.349, BLtri, 3.0

Caniformia, sp. 2

Material. RM¹, P1654.350; RC₁, P1654.351; RP₄, P1654.352; RM₁, P1654.353.

Description. M¹ (Fig. 6H) transverse, concave posterad; parastyle projecting anterad, positioned farther buccad than metastyle; paracone the highest cusp, metacone and protocone of similar height; metaconule low, oblique; paraconule large, crescentic, connected to parastyle; stylar shelf large, flat, confined by buccal cingulum; lingual cingulum continuous from parastyle to metastyle, forming prominent shelf posterolingual to protocone.

C₁ (not shown) roughly oval in cross-section; prominent ridge at anterior face; posterobuccal ridge weak; crown recurved posterolingual.

P₄ (Fig. 6I) of moderate crown height; enamel rugose; protoconid blunt, somewhat recumbent; paraconid large but low, massive, sharply separated from protoconid; metaconid prominent, separated from protoconid, heel cuspid; heel cuspid high, forming elongate, oblique ridge; protoconid, metaconid, heel cuspid forming buccally convex arc; crown sharply widening buccally at protoconid; buccal cingulum strong, cusped at protoconid-paraconid border; lingual cingulum weak.

M₁ trigonid (Fig. 6J) triangular, broadly rounded buccally; not anteroposteriorly elongate; paraconid, metaconid of equal height, lower than protoconid; trigonid basin dipping sharply lingual; anterobuccal cingulum weak; enamel weakly rugose.

Discussion. M¹ and C₁ are similar to Procynodictis vulpiceps and Miacis gracilis, both from the Uinta Formation of Utah. Dawson (1980, pp. 86-87) has pointed out the extreme dental similarity of P. vulpiceps and M. gracilis, and advance of P. vulpiceps to canid grade through fusion of the scapholunar.

M¹ approaches P. vulpiceps and M. gracilis in its large, crescentic paraconule, prominent shelf posterolingual to the protocone, and parastyle set much farther buccad than the metastyle. The parastyle projects more strongly anterad and the crown is more strongly concave posteriorly than in either taxon, and M¹ approaches the canid Hesperocyon in these characters.

C₁ is extremely similar in size, crown height, and dental features to the corresponding teeth of P. vulpiceps and M. gracilis, and is less robust than in Hesperocyon.

The M₁ trigonid is very close to P. vulpiceps and M. gracilis in shape, relative crown height, and strength of the cingulum. The talonid of M₁ appears to have been reduced buccally as in these taxa.

P₄ is of extremely unusual pattern. It is of a size and crown height to belong with the other specimens, and enamel is slightly rugose as in M₁, so I tentatively include it. The slightly recumbent protoconid, buccal expansion at the protoconid, low but massive paraconid, and blade-like posterior cuspid forming an arc with the protoconid and metaconid, are entirely unlike P₄ of P. vulpiceps, M. gracilis, and Hesperocyon. Miacis hargeri of the Upper Bridger shows some buccal crown expansion in P₄, and moderate curvature of the posterior cuspid row, but not to the extent seen in the Swift Current specimen, and the paraconid and posterior cuspids are much smaller.

Thus a caniform with closest similarities to Procynodictis and some Miacis species, and some possible affinities with Hesperocyon, is present at Swift Current.

Measurements. M¹ AP(1), 5.0; BL(1), 8.1; HC(1), 3.1.

C₁, AP(1), 3.3; BL(1), 2.2. P₄ AP(1), 8.1. M₁ BLtri (1), 4.7; HC(1), 7.4

Order Condylarthra
Family Mesonychidae

Harpagolestes sp.

Mesonychidae, genus and species indet. Russell and Wickenden, 1933, p. 59.
Mesonychidae, genus and species indet. Russell, 1965a, p. 11.

Material. LM¹, NMC 8651

Discussion. The only Swift Current specimen is similar in size and occlusal shape to LM¹ in the holotype of Harpagolestes uintensis, AMNH 1892, from Uinta B. The Swift Current specimen is poorly preserved, and M¹ is worn nearly to the roots in H. uintensis, so no more detailed comparison can be made.

The specimen has been illustrated by Russell in Russell and Wickenden (1933, pl. 1, fig. 1) and Russell (1965a, pl. 7, fig. 1).

Measurements. M¹ BL(1), 19.7.

Family Hyopsodontidae

Hyopsodus fastigatus Russell, 1933

Hyopsodus fastigatus Russell in Russell and Wickenden, 1933, p. 61.
Hyopsodus sp. Russell in Russell and Wickenden, 1933, p. 61.
Protoreodon? sp. Russell in Russell and Wickenden, 1933, p. 64.
Hyopsodus fastigatus Russell, 1933; Russell, 1965a, p. 11 (in part).
Epihippus? sp. Russell, 1965a, p. 13 (in part).
Hyopsodus fastigatus Russell, 1933; Gazin, 1968, pp. 15, 30 (in part).
Hyopsodus uintensis Osborn, 1902; Krishtalka, 1979, p. 378 (in part).

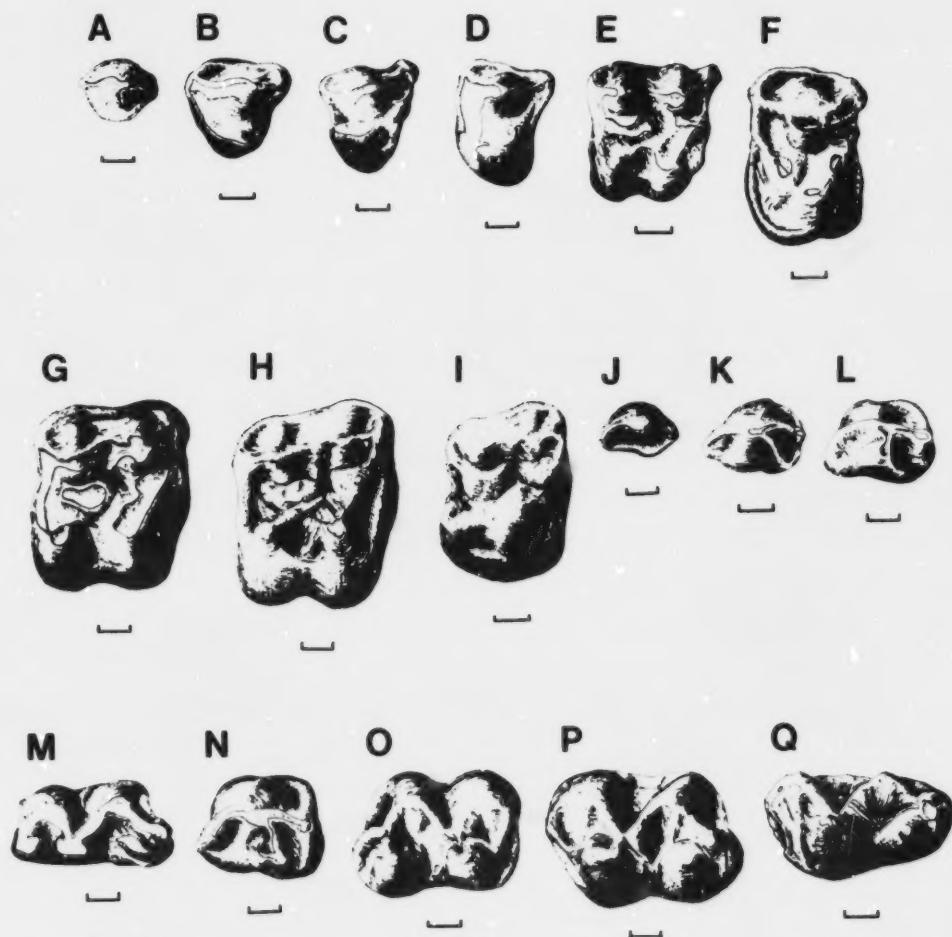


Fig. 7. *Hyopsodus fastigatus*; A, RP¹, P1654.356; B, RP², P1654.359; C, RdP³, P1654.361; D, RP³, P1654.364; E, RdP⁴, P1654.372; F, RP⁴, P1654.381; G, RM¹, P1654.389; H, RM², P1654.396; I, RM³, P1654.399; J, RP₁, P1654.403; K, RP₂, P1654.407; L, RP₃, P1654.408; M, RdP₄, P1654.412; N, RP₄, P1530.3; O, LM₁, P1654.422; P, RM₂, P1654.430; Q, RM₃, P1654.436. Anterior to left in J-N, P, Q, to right in A-I, O; buccal to top of page. Scales 1 mm.

Types. Holotype LM₂, NMC 8654: paratypes LM₁, NMC 8655; LM₂, NMC 8656; LM₃, NMC 8657. All types from Swift Current Creek Locality.

Material. Types and RP¹, P1654.354-356; LP², P1654.357-358; RP², P1654.359-360; RdP³, P1654.361-362; LP³, P1654.363; RP³, P1654.364-366; LdP⁴, P1654.367-371; RdP⁴, P1643.4, P1654.372-378; LP⁴, P1654.379-380; RP⁴, NMC 8665, P1589.3, P1654.381; LM¹, ROM 1686, P1654.382-384; RM¹, ROM 1681, ROM 1687, ROM 23,607, P1654.385-392; LM², P1589.4, P1654.393-395; RM², P1654.396-397; LM³, P1654.398; RM³, NMC 8658, P1654.399-401; LP¹, P1654.402; RP¹, P1654.403-405; LP², P1654.406; RP², P1589.5, P1654.407; RP³, P1654.408-410; LdP⁴, P1654.411; RdP⁴, P1654.412-414; LP⁴, P1654.415-419; RP⁴, P1530.3, P1654.420-421; LM¹, ROM 1683, ROM 23,609, ROM 23,611, P1654.422-424; RM¹, ROM 23,612, P1654.425-429; LM², ROM 23,610; RM², ROM 1682, P1654.430-431; LM³, P1654.432-435; RM³, P1589.6, P1654.436-437.

Emended diagnosis. p²⁻⁴ with long, relatively straight buccal margins, strongly developed posterolingual cingula; P⁴ conules very strong, crown relatively long, squared lingually; M¹⁻³ conules very large, crescentic, but not as large or closely appressed as in H. sholemi; P₂ relatively narrow anteriorly, with oblique metaconid reduced to ridge; P₄-M₃ more hypsodont than in H. uintensis, as hypsodont as in H. sholemi but relatively narrower; M₁₋₃ trigonid more oblique than in H. uintensis, equivalent to H. sholemi.

Description. P¹ (Fig. 7A) single-rooted, nearly oval; parastyle indistinct; posterior cusp small, incorporated into posterior crest from paracone, sending weak cingulum along buccal, lingual margins; protocone weak but distinct; posterolingual shelf well developed.

P² (Fig. 7B) subtriangular, two-rooted; buccal margin nearly straight, with continuous buccal cingulum between prominent parastyle, metastyle; protocone prominent, set in from lingual margin; posterolingual shelf and cingulum strong.

dP³ (Fig. 7C) two-rooted, triangular; parastyle projecting strongly anterobuccad; buccal cingulum interrupted at paracone base; protocone crescentic, connected weakly to paracone; posterolingual cingulum very high, strong.

P³ (Fig. 7D) three-rooted; crown pattern as P² but protocone higher, more crescentic; crown more transverse.

dP⁴ (Fig. 7E) molariform, nearly square in outline; parastyle projecting sharply anterobuccad; buccal cingulum strong but interrupted at cusp bases; para- and metaconule large, crescentic, hypocone as large as protocone, incompletely separated from it; anterior cingulum prominent from paraconule to protocone base.

P⁴ (Fig. 7F) transverse, nearly rectangular in outline, slightly longer lingually than buccally; buccal border only slightly curved, buccal cingulum strong between prominent styles; para- and metaconule very strong, bulbous; protocone high, broadly crescentic.

M¹ (Fig. 7G) relatively quadrate; buccal border nearly anteroposterior, buccal cingulum strong except at cone bases; hypocone slightly smaller than protocone; para- and metastyle large, crescentic; transverse valley completely separating protoloph, metaloph; anterior cingulum prominent; lingual cingulum blocking transverse valley.

M² (Fig. 7H) slightly transverse; buccal border oblique; otherwise as in M¹.

M³ (Fig. 7I) buccal border more oblique, crown more transverse than in M²; hypocone lower than protocone, strongly separated from both protocone and metaconule; para- and metaconule only weakly crescentic; anterior, lingual cingula complete around protocone base.

P₁ (Fig. 7J) single-rooted, elongate-oval; paraconid low, oblique, nearly incorporated into anterior ridge from protoconid; metaconid low, weak, weakly connected to protoconid; posterior cusp central, low but distinct, sending weak cingula linguad and buccad.

P₂ (Fig. 7K) single-rooted, relatively broader than P₁; paraconid, metaconid oblique, incorporated into sloping ridges from protoconid; posterior cusp strongly connected to protoconid, with strong but short cingula.

P₃ (Fig. 7L) two-rooted, crown widest posteriorly; metaconid high, nearly lateral to protoconid; posterior cusp very strong, with strong, short cingula; anterobuccal cingulum weak.

dP₄ (Fig. 7M) strongly lophate, elongate; paraconid connected by anterolingual ridge to protoconid; basins open linguallly; entoconid, hypoconulid subequal, weakly separated, projecting posterolingual.

P₄ (Fig. 7N) relatively broad posterad; anterobuccal cingulum stronger than in P₃.

M₁ (Fig. 7O) relatively rectangular; anterior, posterior cingula nearly transverse, long; protocone, hypocone less broadly crescentic than in M₂; trigonid slightly oblique; entoconid very large, high, well separated from low hypoconulid; talonid basins opening linguallly.

M₂ (Fig. 7P) relatively longer than M₁; protoconid, hypoconid broadly crescentic; crown parallelogram-shaped, with lophids and cingula very oblique; entoconid large, more bulbous than in M₁.

M₃ (Fig. 7Q) tapering posterad; cusps broadly crescentic; trigonid, anterior cingulum as oblique as in M₂; entoconid slightly higher than hypoconulid, well separated.

Discussion. Hyopsodus fastigatus was previously known from few specimens. Krishtalka (1979), in the latest revision of advanced Hyopsodus, considered H. fastigatus a junior synonym of H. uintensis. The SMNH sample demonstrates the distinctness of H. fastigatus, and I resurrect the species.

H. fastigatus differs from H. uintensis as follows: p^{3-4} posterobuccal corners more strongly developed; P^4 conules larger; M^{1-2} para- and metaconule larger and more crescentic, hypocone relatively larger; P_3 metaconid higher, more distinct; P_{3-4} posterior cingula stronger; M_{1-2} higher-crowned; M_2 anterior and posterior borders more oblique, trigonid more compressed, oblique. Many measurements exceed known ranges for H. uintensis, and H. fastigatus is slightly larger on average.

H. fastigatus approaches the size of H. sholemi from the Duchesneau of Montana (Krishtalka, 1979), and crown heights are similar, but in H. fastigatus M^{1-3} para- and metaconules are smaller and more widely separated; M^{1-2} are relatively less transverse; P_{3-4} do not broaden as markedly posterad; and M_{1-2} are not as broad.

P^{1-2}_{1-2} and deciduous premolars have not been reported for later Eocene Hyopsodus. P^1_1 are far more complex than in Wasatchian and Bridgerian species. P^1 in H. fastigatus is distinctly premolariform, with anterior cingulum and weak protocone, as compared to earlier species' acutely conical P^1 with anteriorly and posteriorly crested paracone occupying the entire crown; but P^1 complexity never equals that of P^2 of even Wasatchian species (Gazin, 1968, pl. 8, fig. 1). P_1 is advanced in pattern over P_2 of earlier species (op. cit., pl. 9, fig. 6), and is fully premolariform, approaching P_{3-4} pattern.

P^2 has a better developed posterolingual area than in earlier species, and in Wasatchian-Bridgerian materials the conspicuous protocone is developed "only in the type of H. marshi from the upper Bridger" (op.

cit., p. 45), with far less transverseness and lingual development typical in even Bridgerian material (West, 1979, fig. 12). P^2 is two-rooted as in nearly all known Hyopsodus (Gazin, 1968, p. 45).

P_2 is single-rooted as in Wasatchian species and some H. paulus (op. cit., p. 48), and approaches P_3 in pattern.

dP^3 is more expanded anteriorly than in H. lepidus of the Bridger (West, 1979, fig. 15), dP^4 is more lophiodont, with stronger protocone-hypocone separation, and dP_4 may have a stronger paraconid, and shows complete separation of the entoconid.

Thus H. fastigatus differs from Wasatchian-Bridgerian Hyopsodus not only in features cited by Krishtalka (1979, p. 388), but also in P^{1-2} lingual development, with protocone incipient in P^1 and prominent in P^2 ; P_{1-2} complexity approaching that of P_{3-4} ; dP^3 anterior expansion; dP^4 pattern corresponding with M^{1-2} in lophiodonty and strength of the lingual valley; and dP_4 with complete entoconid separation as in M_{1-3} .

I agree with Krishtalka's reassignment (op. cit., p. 384) of ROM 1686 and 1687 to Hyopsodus, and exclusion of ROM 1684 from Hyopsodus (it is RM_3 of the leptchoerid artiodactyl Ibarus ignotus described in this monograph). NMC 8665, referred by Russell in Russell and Wickenden (1933, p. 64) to Protoreodon?, is RP^4 of Hyopsodus. NMC 8658, referred originally to "a smaller species of Hyopsodus" (op. cit., p. 61), is of appropriate size for reference to M^3 of H. fastigatus, and the hypocone, though reduced, is isolated from the protocone and metaconule as in other Swift Current examples.

Measurements. P^1 AP(3), mean 2.4, OR 2.3-2.5; BL(3), mean 1.9, OR 1.8-2.1; HC(2), mean 2.5, OR 2.4-2.5. P^2 AP(3), mean 2.9, OR 2.5-3.2; BL(3), mean 2.8, OR 2.4-3.1. dP^3 AP(2), mean 3.0, OR 2.9-3.0; BL(2), mean 3.2, OR 3.2-3.2. P^3 AP(4), mean 3.2, OR 2.9-3.6; BL(4), mean 3.7, OR 3.5-4.0. dP^4 AP(9), mean 3.9, OR 3.4-4.3, CV 6.9; BL(10), mean 4.2, OR 3.8-4.5, CV 4.8. P^4 AP(5), mean 3.2, OR 2.9-3.4, CV 6.3; BL(5), mean 5.0, OR 4.5-5.5, CV 8.0; HC(2), mean 3.6, OR 3.6-3.6. M^1 AP(7),

mean 4.9, OR 4.5-5.3, CV 7.1; BL(7), mean 5.7, OR 5.4-6.2, CV 4.7;
HC(2), mean 3.4, OR 3.3-3.4. M^2 AP(6), mean 4.8, OR 4.4-5.0, CV 5.6;
BL(6), mean 6.4, OR 6.2-6.7, CV 3.6; HC(4), mean 3.5, OR 3.3-3.6. M^3
AP(3), mean 3.6, OR 3.4-3.8; BL(3), mean 5.2, OR 4.8-5.4. P_1 AP(4),
mean 2.2, OR 1.9-2.4; BL(4), mean 1.6, OR 1.5-1.6; HC(1), 2.8. P_2
AP(2), mean 2.8, OR 2.6-2.9; BL(3), mean 2.0, OR 1.9-2.1; HC(1), 3.1.
 P_3 AP(2), mean 3.2, OR 3.1-3.3; BL(3), mean 2.5, OR 2.3-2.6; HC(1),
2.5. dP_4 AP(3), mean 4.9, OR 4.8-5.0; BLtri(4), mean 2.6, OR 2.4-2.8;
BLtal(3), mean 2.8, OR 2.7-2.8. P_4 AP(4), mean 3.8, OR 3.6-3.9; BL(6),
mean 2.7, OR 2.4-3.0, CV 9.3. M_1 AP(6), mean 4.9, OR 4.6-5.2, CV 4.1;
BLtri(11), mean 3.5, OR 3.1-3.8, CV 6.3; BLtal(9), mean 3.6, OR 3.2-
3.8, CV 5.6; HC(2), mean 3.6, OR 3.4-3.8. M_2 AP(4), mean 5.5, OR 5.2-
5.6; BLtri(4), mean 3.8, OR 3.6-4.0; BLtal(5), mean 3.7, OR 3.4-4.2, CV
8.4; HC(1), 4.3. M_3 AP(4), mean 5.3, OR 4.9-5.6; BLtri(5), mean 3.2,
OR 3.0-3.6, CV 7.2; BLtal(5), mean 2.8, OR 2.7-3.1, CV 6.1; HC(1), 2.9.

Order Perissodactyla

Family Equidae

Epihippus cf. E. gracilis (Marsh, 1871)

Epihippus? sp. Russell in Russell and Wickenden, 1933, p. 63.

Epihippus? sp. Russell, 1965a, p. 12.

Epihippus? sp. Russell, 1965a, p. 13 (in part).

Material. RP^2 , P1654.438; LP^4 or M^1 or M^2 , NMC 8661, P1654.439; RdP_2 ,
P1589.7; RdP_3 , P1654.440; RP_4 or M_1 or M_2 , ROM 23,593, P1530.4; LM3,
ROM 1688.

Discussion. In size and occlusal pattern, these specimens agree with
Epihippus gracilis, though identification of such scanty material
cannot be definite.

Krishtalka (1979, p. 384) placed previously assigned upper teeth ROM 1686 and 1687 in Hyopsodus. I agree.

Measurements. p^2 BL(1), 8.3; HC(1), 3.9. dP_2 AP(1), 9.2; BL(1), 5.3. dP_3 BL(1), 4.9. P_4 or M_1 or M_2 AP(1), 8.6; BLtri(1), 6.3; BLtal(1), 6.4. M_3 AP(1), 11.8; BLtri(1), 6.3; BLtal(1), 5.5.

Family Brontotheriidae

Brontotheriidae, gen. et sp. indet.

Diplacodon sp. Russell in Russell and Wickenden, 1933, p. 62.
Diplacodon sp. Russell, 1965a, p. 14.

Material. RdP^4 , P1589.8; RP^4 , NMC 8660.

Discussion. A broken dP^4 (Fig. 8A) matches the corresponding tooth of Diplacodon progressus, and P^4 (Russell, 1965a, pl. 7, fig. 3) is close in size and occlusal pattern to Diplacodon elatum.

There is a similarity in size to Eotitanotherium osbornii, but in the Swift Current P^4 the buccal margin is nearly straight, while in E. osbornii it is markedly concave.

Although tooth shapes are different, this material is about the size of Duchesnodus uintensis (Lucas and Schoch, 1982) and Protitanotherium emarginatum. Swift Current specimens are larger than corresponding elements of Telmatherium ultimum, Manteoceras uintensis, Dolichorhinus superior, and Metarhinus fluviatilis.

The Swift Current titanotherium represents a large species for the Uintan, and available elements are closest to species of Diplacodon, as Russell in Russell and Wickenden (1933, p. 62) pointed out. With such poor material, I feel that even generic identification is unwarranted.

Measurements. dP^4 AP(1), 32.7; BL(1), 27.1. P^4 AP(1), 36.6; BL(1), 39.2.

Family Helaletidae

Colodon cf. C. kayi (Hough, 1955)

Hyrachyus intermedius Osborn, Scott and Speir, 1878; Russell in Russell and Wickenden, 1933, p. 62.

Hyrachyus intermedius Osborn, Scott and Speir, 1878; Russell, 1965a, p. 14.

Material. RP^1 , NMC 9163; LP^2 , P1589.9; RP^3 , P1654.441; RM^1 or M^2 , ROM 9095, P1654.442; LH^3 , NMC 8659; RP_4 or M_1 or M_2 , P1530.5, P1654.443.

Discussion. Radinsky (1963, p. 60) referred Hough's species Desmatotherium kayi to Colodon, and (op. cit., p. 70) pointed out the similarity of the Swift Current M^3 to the holotype.

P^1 is of appropriate size and occlusal pattern but is proportionally much broader than the corresponding tooth in Colodon woodi and other described species. P^1 was not present in the Badwater type material of C. kayi.

Other Swift Current specimens are fragmentary, but agree in visible details with Colodon kayi. I consider size differences between Swift Current material and C. kayi to be minor.

Measurements. P^1 AP(1), 6.9; BL(1), 6.9. M^3 AP(1), 16.4; BL(1), 19.4. P_4 or M_1 or M_2 BLtal(1), 8.6.

?Dilophodon sp.

Material. ?RdP⁴, P1654.444.

Description. The specimen as preserved (Fig. 88) is an enamel cap, unworn; crown low (apparent height at paracone, 2.7); lophs curved, without conules; cingula strong, complete except at lingual base of hypocone; anterior cingulum beaded; metacone displaced slightly lingual; crown slightly longer than broad.

Discussion. There is a close resemblance in tooth length to Dilophodon leotanus (Radinsky, 1963, table 8; Black, 1979, table 3), and general similarity in pattern. The specimen is lower-crowned and more cingulate than permanent teeth of D. leotanus, and the tooth is longer than broad: in D. leotanus M¹⁻², the crown is 10-25% broader than long. Pattern similarity includes the large, oblique parastyle separated from the paracone, and metacone located somewhat lingually.

Perhaps this is the previously unknown dP⁴ of Dilophodon. If so, it is an unusual specimen, because unworn enamel caps normally represent permanent tooth buds, not deciduous teeth.

Measurements. ?dP⁴ AP(1), 6.5; BL(1), 6.2.

Order Artiodactyla
Family Dichobunidae
Subfamily Homacodontinae

Mytonomeryx scotti Gazin, 1955

cf. Bunomeryx sp. Russell in Russell and Wickenden, 1933, p. 63.
Dichobunidae, genera and species undetermined Russell, 1965a, p. 15 (in part).

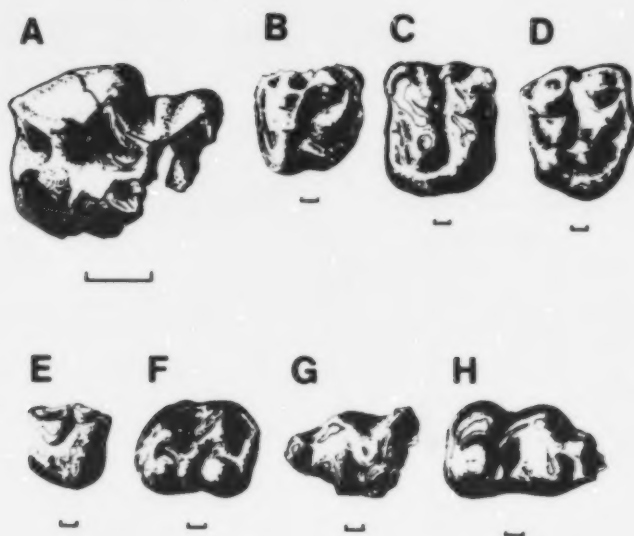


Fig. 8. A, Brontotheriidae, gen. et sp. indet., RdP⁴, P1589.8. B, ?*Dilophodon* sp., ?RdP⁴, P1654.444. C, *Mytonomeryx scotti*, LM², P1654.445. D-H, *Auxontodon processus*; D, RM¹ or M², P1654.449; E, RM³, P1589.10; F, RM₁ or M₂, ROM 35,026; G, LM₃, P1654.456; H, RM₃, P1654.457 (holotype). Anterior to left in C, F, H, to right in A, B, D, E, G; buccal to top of page. Scale in A, 10 mm; in B-H, 1 mm.

Material. LM^2 , P1654.445; LM_1 or M_2 , ROM 1692, P1654.446; RM_1 or M_2 , NMC 8663; LM_3 , P1654.447.

Discussion. LM^2 (Fig. 8C) from the Swift Current sample is nearly identical to M^2 in the holotype of Mytonomeryx scotti, USNM 20401, from the Myton Pocket, Uinta Formation of Utah, and differs only in its slightly less separate hypocone. Referred lower molars are of appropriate size, with homacodontine features: distinct but low paraconid not strongly separated from metaconid; bunoselenodont cusps; and entoconid connected transversely, with central hypoconulid projecting posterad.

Other specimens referred to the Dichobunidae by Russell (1965a, p. 15) I assign as follows: NMC 8662, LM^1 or M^2 , to Pseudotomus; ROM 1691, RM_1 or M_2 , to Oromerycidae, gen. et sp. indet.; and ROM 1693, LM_1 or M_2 , to Protoreodon.

Measurements. M^2 AP(1), 6.5; BL(1), 7.6. M_1 or M_2 AP(1), 6.3; BLtri(2), mean 4.5, OR 3.7-5.2; BLtal(1), 4.2.

Subfamily Antiacodontinae

Auxontodon processus, sp. nov.

Type. Holotype RM_3 , P1654.457.

Material. Holotype and LM^1 or M^2 , P1654.448; RM^1 or M^2 , P1654.449-451; RM^3 , P1589.10; LdP_4 , P1654.452; RM_1 or M_2 , ROM 35,026, P1654.453-455; LM_3 , P1654.456; RM_3 , P1530.6.

Diagnosis. Teeth larger than in Auxontodon pattersoni; lower molars relatively broader; paraconids larger; cristid obliqua connecting directly with metaconid; upper molars with continuous cingula around crown except at hypocone; para- and metaconule strongly crescentic, as high as protocone; M^{1-2} hypocone distinct, strongly joined to

protocone; buccal styles strong; parastyle shelf-like and projecting anterobuccad; mesostyle high, strongly joined to buccal cusps, projecting buccad.

Etymology. Latin processus, past participle of procedere, to go forward.

Description. M^1 or M^2 (Fig. 8D) relatively quadrate; crown height moderate; strong, continuous cingula surrounding crown except at hypocone; para- and metaconule strongly crescentic, as high as protocone; hypocone strong, at posterolingual corner of crown, strongly joined to protocone, separated from metaconule; buccal styles strong; parastyle forming shelf projecting anterobuccad; mesostyle very high, strongly joined to buccal cusps, projecting buccad; major cusps, cuspules forming pentagon.

M^3 (Fig. 8E) fragmentary; hypocone lower, more buccal than in M^{1-2} , not strongly joined to protocone; crown smaller than in M^{1-2} .

dP_4 poorly preserved, tentatively referred; entoconid, hypoconid connecting to metastylid, protoconid, leaving talonid, trigonid confluent; hypoconulid projecting strongly posterad; paraconid apparently large, separated from metaconid; buccal valley blocked by strong, low cuspule.

M_{1-2} (Fig. 8F) trigonids not greatly elevated over talonids; talonid broader than trigonid; paraconid very large, much higher than metaconid and strongly separated from it, connected to protoconid anteriorly by strong, curved ridge; cristid obliqua joining metaconid directly; entoconid as high as hypoconid, connected transversely to postcristid; hypoconulid projecting buccad, giving rise to strong posterior cingulum; anterior cingulum complete but weak.

M_3 (Figs. 8G,H) paraconid not strongly separated from metaconid; posterolophid a high, bulbous cusp and ridge inflected linguad from hypoconulid.

Discussion. Lower molars are similar to those of Auxontodon pattersoni (Gazin, 1958b), but are larger and relatively broader, with larger paraconids, greater paraconid-metaconid separation in M_{1-2} , and cristid obliqua joining directly with the metaconid. Relative crown heights are similar.

Upper molars have not been reported for Auxontodon. The Swift Current specimens are generally similar to Antiacodon, but are higher-crowned, with much stronger styles, conules, cingula, and hypocones.

Badwater upper molars CM 14552 and 19785, reported by Black (1978, p. 232) appear to represent Auxontodon, but have smaller hypocones, with the M^2 hypocone not as strongly joined to the protocone as in A. processus. As Black (loc. cit.) stated, these teeth may well represent A. pattersoni.

Another antiacodontine dichobunid is Neodiacodexis emryi (West and Atkins, 1970), from the upper Bridger of Tabernacle Butte, Wyoming. Neodiacodexis seems to me to be excluded from the diacodexines, and also from the ancestry of the leptchoerids, by its more quadrate and cingulate upper molars, with larger hypocones, strongly developed mesostyles, and stronger para- and metaconules. Neodiacodexis has much more strongly crescentic conules than any reported leptchoerid.

The above characteristics unite Neodiacodexis with Antiacodon and Auxontodon, rather than with the diacodexines. Upper teeth are higher-crowned than in Antiacodon, with stronger cingula, and M^{1-2} have more crescentic conules, a relatively larger protocone, a stronger mesostyle, and a less sharply defined hypocone.

Neodiacodexis cannot be compared with the holotype lower dentition of Auxontodon pattersoni: A. processus M^{1-2} are slightly larger and more quadrate; are equivalent in crown height; and have stronger, higher cingula; stronger para- and mesostyle; and high and well-defined hypocone.

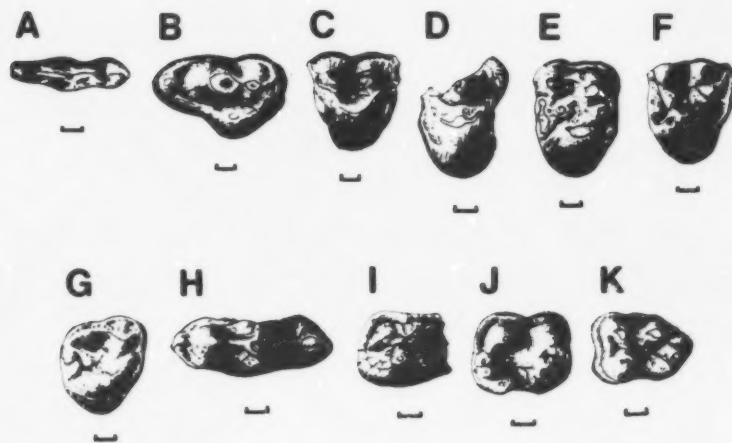


Fig. 9. *Ibarus ignotus*; A, LP², P1654.458; B, LP³, P1654.459; C, RdP⁴, P1654.463; D, RP⁴, P1654.465; E, RM¹ or M², P1654.468; F, RM¹ or M², P1654.469; G, RM³, P1654.471; H, LP₃, P1589.11; I, LP₄, P1654.474; J, LM₁ or M₂, P1589.12 (holotype); K, RM₃, P1654.479. Anterior to left in A, B, K, to right in C-J; buccal to top of page. Scales 1 mm.

I suspect that Neodiacodexis is a distinct genus of antiacodontine dichobunids, and its reduced hypocone indicates that it may be on an evolutionary sideline parallel to Auxontodon rather than a member of a direct Antiacodon-Auxontodon lineage.

Measurements. M^1 or M^2 AP(1), 6.8; BL(1), 8.1; HC(1), 4.1. dP_4 BLtal(1), 4.8. M_1 or M_2 AP(3), mean 7.0, OR 6.7-7.1; BLtri(3), mean 4.7, OR 4.5-5.1; BLtal (2), mean 5.3, OR 5.0-5.6; HC(1), 4.0. M_3 BLtri(1), 5.4; BLtal(2), mean 4.8, or 4.5-5.1.

Family Leptochoeridae

Ibarus, gen. nov.

Type species. Ibarus ignotus, sp. nov.

Diagnosis. Cheek teeth low-crowned; P_{3-4}^3 elongate, narrow relative to molars; molar series not massive as in Leptochoerus; M_3^3 relatively unreduced; M^{1-3} conules bulbous, not strongly crescentic; M_{1-3} hypoconulid, accessory cusp, entoconid subequal, set in arc; M_3 talonid shorter than in Oligocene taxa.

Included species. Type species only.

Etymology. Ibarus, a shortening of Stibarus.

Ibarus ignotus, sp. nov.

Hyopsodus fastigatus Russell, 1933; Russell, 1965a, p. 11 (in part).

Type. Holotype LM₁ or M₂, P1589.12.

Material. Holotype and LP², P1654.458, P1654.480; LP³, P1654.459-461; RP³, P1654.462; RdP⁴, P1654.463-464; RP⁴, P1654.465; LM¹ or M², P1654.466-467; RM¹ or M², P1654.468-469; RM³, P1654.471; LP₃, P1589.11, P1654.472; RP₃, P1654.473; LP₄, P1654.474; LM₁ or M₂, NMC 9166, P1654.475-477; RM₁ or M₂, P1654.478; RM₃, ROM 1684, P1654.479.

Diagnosis. Within generic diagnosis.

Etymology. Latin ignotus, unknown, low-born.

Description. Enamel of cheek teeth lightly rugose.

p² (Fig. 9A) paracone large, pointed; low parastyle separated by distinct notch from paracone; metacone about half height of paracone, connected by low ridge; minute posterior cusp behind metacone.

p³ (Fig. 9B) paracone very large, bulbous; metacone set close to paracone and very high; parastyle low, separated from paracone by sharp notch; protocone low, posterolingual to paracone; cingula complete except at parastyle, paracone, protocone bases.

dP⁴ (Fig. 9C) nearly triangular, brachydont; paracone, metacone subequal, connected by low ridge; protocone broadly crescentic, with hypocone ridge posterad; paraconule, metaconule distinct, low, weakly crescentic; anterior, posterior cingula short; styler area small but well defined, with distinct, buccally inflected parastyle, metastyle; mesostyle absent.

p⁴ (Fig. 9D) incompletely preserved; cusps bulbous; conules absent; anterior cingulum low, short; posterior cingulum long, distinct; parastyle oblique.

M¹⁻² (Figs. 9E,F) low-crowned; para- and metaconule distinct, low, weakly crescentic; hypocone ridge weak but distinct; para- and metastyle weak, mesostyle absent; anterior, posterior cingula strong; metaconule, protocone separated by sharp, narrow valley extending from central basin to posterolingual edge of crown.

M³ (Fig. 9G) crown reduced posterad; metastyle reduced; protocone, metaconule joined.

P₃ (Fig. 9H) protoconid elongate, high; paraconid, metaconid subequal, strongly separated from protoconid; low posterior cusp behind metaconid.

P₄ (Fig. 9I) incompletely preserved; protoconid high, bulbous; metaconid distinct, anterolingually oriented; talonid broad; cingula complete around posterior and lingual edges of crown.

M₁₋₂ (Fig. 9J) metaconid highest cusp, weakly connected to protoconid posteriorly; paraconid very small but distinct, lower than metaconid; pair of cusps on posterolingual face of metaconid; trigonid anteroposteriorly compressed, transverse; hypoconid nearly as high as protoconid; hypolophid with central hypoconulid, another cuspule, and large, distinct entoconid; cuspule anterior to entoconid; posterior cingulum complete, weak lingually and strong buccally; anterior cingulum low but traversing entire anterior margin; buccal cingulum interrupted by median valley.

M₃ (Fig. 9K) trigonid anteroposteriorly compressed, slightly oblique; paraconid connected to anterior protoconid arm and metaconid separated from protoconid; talonid lower, longer anteroposteriorly than in M₁₋₂; hypoconulid set much farther posterad than in M₁₋₂; posterior cingulum lacking.

Discussion. Previously recognized leptchoerids have come from Oligocene deposits, except for one tooth from the latest Eocene (Black, 1978). Among Oligocene forms, I recognize two genera, Leptchoerus and

Stibarus. I do not recognize Nanochoerus (Macdonald, 1955), whose diagnosis includes " M_{1-3} without paraconids; ... M^1 with well developed hypocone" (op. cit., pp. 452-453). A small paraconid is present in all unworn leptocherid M_{1-3} that I have examined: it is always small and poorly separated from the metaconid, and evidently disappeared early in occlusal wear. M^{1-2} hypocones are always expressed as steeply plunging ridges posterior to the protocone, and samples I have examined indicate that this ridge was variable in strength, and that apparent hypocone size depends partly on the stage of occlusal wear. I feel that species formerly assigned to Nanochoerus can be accommodated satisfactorily within Leptocherid or Stibarus.

In Stibarus, the major evolutionary trends in the dentition involved retention of relatively narrow P_{3-4}^{3-4} , and progressive reduction of M_{2-3}^{2-3} . Stibarus had smaller and less massive dental elements than contemporaneous Leptocherid. Edwards (1976) also pointed out that the rostrum of Stibarus was elongate, and narrow anteriorly.

Leptocherid is marked at its first appearance in the Chadronian (undescribed RP_4-M_1 , CM 2018, Pipestone Springs Local Fauna) by relatively massive P_4-M_1 , with P_4 broader than M_1 , and evolutionary trends in the dentition include progressively massive teeth, particularly $P_3-M_1^{3-1}$, and less relative reduction of M_{2-3}^{2-3} than in Stibarus. Leptocherid was represented by larger, more massive dental elements than contemporaneous Stibarus, and all Leptocherid $P_{3-4}^{3-4} - M_1^1$ were more massive than any known Stibarus elements. The skull had a short, broad, unpinched rostrum (Edwards, 1976).

This brief, undetailed overview of Oligocene leptocherids provides a basis for discussion of the Eocene genus Ibarus. Ibarus ignotus of the Swift Current Creek Local Fauna had lower-crowned cheek teeth than Stibarus and Leptocherid; M_3 relatively unreduced, but less elongate with talonid shorter than in Oligocene taxa; M^3 relatively unreduced; and M_{1-3} hypoconulid, accessory cusp, and entoconid subequal and set in an arc. Upper molar conules are less crescentic than in Oligocene

taxa. p^{3-4} and M^1 are relatively slender, and not as massive as in Leptochoerus, with p^{3-4}_4 apparently narrower than M^1_1 as in Stibarus.

Ibarus has obvious similarities to Stibarus, especially in premolar proportions, but its relatively unreduced M^3_3 gives some resemblance to Leptochoerus. I. ignotus represents a dental condition possibly ancestral to both Oligocene genera; the retention in Stibarus of elongate, narrow premolars and reduction of posterior molars, and the trend in Leptochoerus toward progressively massive premolars and M^1_1 , with little reduction of posterior molars, could both have arisen from Ibarus.

The leptuchoerid lower molar reported from Badwater by Black (1978) remains problematical. Its trigonid is relatively longer than in Ibarus or the Oligocene genera and it is very small. It does not appear to fit any known genus.

I agree with Macdonald (1955) and Black (1978) that the Leptochoeridae are a valid family, distinguished by premolar morphology quite different from dichobunids, at least some reduction of posterior molars in all known species, and more weakly, a considerable temporal hiatus between known leptuchoerids and taxa that could be ancestral to them. Van Valen (1971) and Edwards (1976) preferred to place known taxa in the Leptochoerinae, as a subfamily of the Dichobunidae.

It seems to me that differences between leptuchoerids and dichobunids outweigh similarities, and that it is important to retain the familial distinction.

The ancestry of the Leptochoeridae is still unclear. Gazin (1955) and later authors have suggested that leptuchoerids might have arisen from diacodexine dichobunids, and indeed the diacodexines show some dental similarity. Diacodexines have bunodont upper molars with cusps and conules arranged in a pentagon and mesostyles lacking, and lower molars with reduced paraconids. But known Diacodexis upper molars have more crescentic conules than do early leptuchoerids.

The known postcranial material also indicates that Diacodexis was probably not ancestral to leptchoerids. Marsh (1875) described postcranial material apparently referable to Leptchoerus: it agrees with postcranial elements of Diacodexis (Rose, 1982) in the strong ulna, separate from the radius; fibula and tibia fused distally; and hind foot with four functional digits. In Leptchoerus, the cuboid and navicular were co-ossified, an advance over Diacodexis. But pedal elements in Diacodexis metsiacus were elongated (Rose, 1982) while those of Leptchoerus were not: the advanced pes of D. metsiacus eliminates at least that species from leptchoerid ancestry.

A proposed Bridgerian ancestor of the leptchoerids, Neodiacodexis (West and Atkins, 1970) is not suitable in dental features for such a position (see discussion under Auxontodon processus), and the high, crescentic conules and strong mesostyles unite Neodiacodexis with the antiacodontine dichobunids. Moreover, one would expect a relatively larger and more rounded P^4 in a late leptchoerid ancestor.

Measurements. P^2 AP(2), mean 5.5, OR 5.5-5.5; BL(2), mean 1.5, OR 1.5-1.5. P^3 AP (3), mean 5.9, OR 5.7-6.1; BL(3), mean 4.0, OR 4.0-4.1; HC(1), 3.9. dP^4 AP(1), 4.5; BL(2), mean 4.6, OR 4.3-4.8. M^1 or M^2 AP(2), mean 3.9, OR 3.8-3.9; BL(2), mean 5.6, OR 5.5-5.6. M^3 AP(1), 4.1; BL(1), 4.4; HC(1), 2.0. P_3 AP(1), 6.9; BL(1), 2.8; HC(1), 3.5. P_4 BL(1), 3.5; HC(1), 4.2. M_1 or M_2 AP(4), mean 4.5, OR 4.4-4.6; BLtri (4), mean 3.6, OR 3.4-4.0; BLtal(6), mean 3.7, OR 3.4-4.3, CV 8.6; HC(3), mean 3.1, OR 3.1-3.2. M_3 AP(2), mean 4.7, OR 4.5-4.8; BLtri(2), mean 3.4, OR 3.3-3.5; BLtal(2), mean 3.2, OR 3.1-3.2; HC(1), 3.3.

Family Oromerycidae

Oromerycidae, gen. et sp. indet.

Oromeryx? sp. Russell, 1965a, p. 17.

Dichobunidae, genera and species undetermined Russell, 1965a, p. 15 (in part).

Leptotragulus proavus Scott and Osborn, Russell, 1965a, p. 16 (in part).

Material. LP³, P1654.481-485; RP³, P1654.486-489; LdP⁴, NMC 9162, P1654.490-492; RdP⁴, P1654.493-494; LP⁴, ROM 35,031, P1654.495-496; LM¹ or M², P1654.497-501; RM¹ or M², NMC 9161, ROM 1694-1696, ROM 23,590, P1589.13, P1654.502-504; RP₃, P1654.505; LdP₄, P1654.506-509; RdP₄, P1654.510-514; LP₄, P1654.515; LM₁ or M₂, ROM 1690, P1589.14, P1654.516-520; RM₁ or M₂, ROM 1691, P1644.1, P1654.521-528; L mandibular fragment with M₂₋₃, P1654.529; LM₃, ROM 23,592, P1589.15.

Description. P³ (Figs. 10A,B) three-rooted; paracone high, bulbous; metacone variable in size, distinct or nearly lost in posterior ridge from paracone; metastyle a high, oblique ridge; parastyle prominent, oblique; protocone always evident, but variable in size and position; lingual cingulum, complete from protocone to para- and metastyle.

dP⁴ (Fig. 10C) molariform; parastyle strong, inflected posterobuccad; mesostyle projecting buccad; metaconule oblique; no forking of postprotocrista evident; anterior cingulum distinct but low; posterior cingulum lacking.

P⁴ (Fig. 10D) slightly broader than long; metacone small but distinct; para- and metastyle inflected buccad; protocone broadly crescentic; anterior, posterior cingula weak, low.

M¹⁻² as described, figured by Russell (1965a, p. 17; pl. 6, figs. 3-4); metaconule set relatively far buccal to protocone; M³ not known.

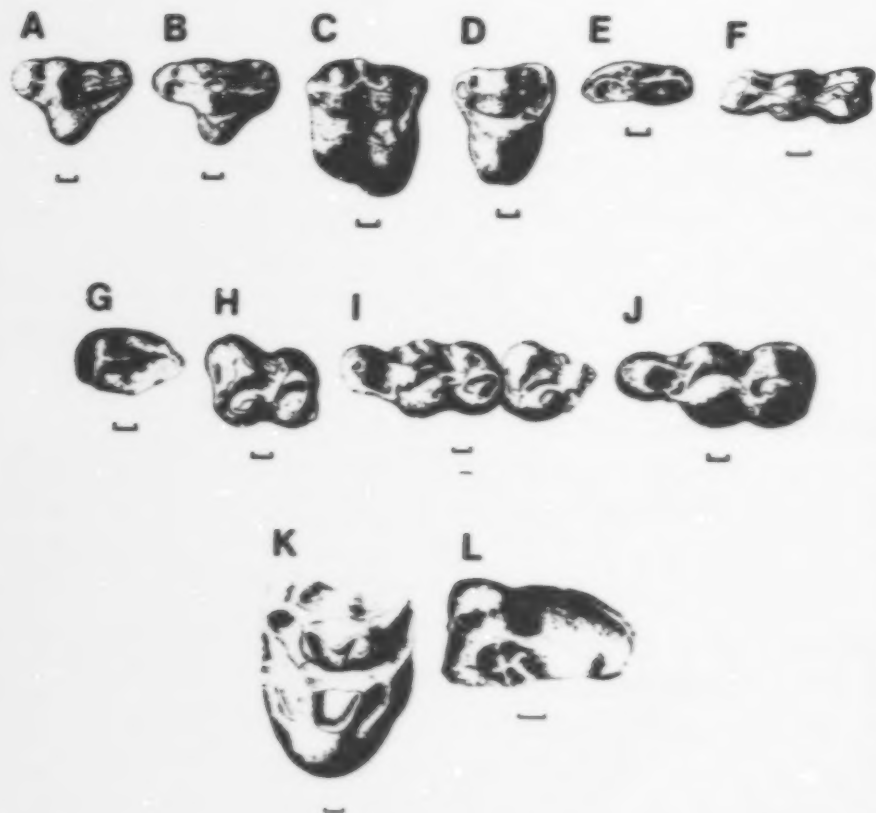


Fig. 10. A-J, Oromerycidae, gen. et sp. indet; A, LP³, P1654.481; B, LP³, P1654.483; C, RdP⁴, P1654.493; D, LP⁴, P1654.495; E, RP³, P1654.505; F, RdP⁴, P1654.510; G, LP⁴, P1654.515; H, LM₁ or M₂, P1654.516; I, LM₂₋₃, P1654.529; J, LM₃, P1589.15. K, *Protoreodon pumilis*, LP⁴, P1654.532. L, *Leptoreodon marshi*, LP⁴, P1654.609. Anterior to left in A, B, D-F, K, to right in C, G-J, L. Scales 1 mm.

P₃ (Fig. 10E) tentatively referred; crown elongate, narrow; paraconid sharply inflected linguad; protoconid high, sharp; metaconid lacking; three ridges at posterior end of protoconid, the central one connecting to a posterior cusp; posterior cusp sending buccal ridge posterad, curving to posterolingual corner of crown, and short lingual ridge.

dP₄ (Fig. 10F) elongate, three-lobed; anterolophid cusps connected anteroposteriorly to protoconid, metaconid; anterolophid, trigonid basins confluent, trigonid closed posteriorly; entoconid strongly connected to metaconid; cristid obliqua very weak, low; postcristid oblique; hypoconulid transverse, weakly connected to entoconid; buccal valleys blocked by cingula.

P₄ (Fig. 10G) tentatively referred; paraconid sharply inflected linguad; metaconid ridged but nearly as high as protoconid, projecting anterad; strong ridge extending from protoconid to posterior cusp; talonid basin open posterobuccad.

M₁₋₂ (Figs. 10H,I; Russell, 1965a, pl. 4, fig. 2) trigonid oblique, closed anteriorly and posteriorly; entoconid high, elongate, separate from postcristid, connected to metaconid by anteroposterior ridge; anterolingual face of entoconid with strong pocketed indentation; cristid obliqua sloping anterad, joining protoconid base; anterior, posterior cingula strong; buccal valley blocked by large, triangular column.

M₃ (Figs. 10I,J) posterolophid narrow; large cusp at posterobuccal edge of posterolophid, connected to postcristid, entoconid by low, curving ridges; two cusps posterior to entoconid.

Discussion. This sample, largely composed of fragmentary specimens, shows dental patterns characteristic of the Oromerycidae: upper molar protocones bifurcate posteriorly, and buccal ribs and styles are well developed; and in lower molars, deep pockets are developed at the anterolingual sides of the entoconids.

The Swift Current material represents an undescribed genus and species, but the specimens are such that I hesitate to name it. Upper molars are distinct from described Eocene-Oligocene genera in their relative transverseness (more strongly developed than in Protylopus), and in the extreme buccal offsetting of the posterior loph. Lower molars resemble Eotylopus rather than Protylopus or Oromeryx in the complete entoconid-metaconid connection, and compared to other genera are relatively long and narrow, with a very narrow posterolophid in M_3 .

Interestingly, this oromerycid appears to have been evolutionarily convergent with early leptomerycids. Although the groups are separated by a host of non-dental characters (Webb and Taylor, 1980), and the Swift Current form's relatively bulbous cusps, posterior forking of the protocone, and anterolingual pocketing of the entoconid confirm its oromerycid affinities, the Swift Current form is strikingly similar to Hendryomeryx (Black, 1978, p. 255) in other features of dental pattern, including transverseness of P^4-M^2 ; buccal offsetting of the posterior loph in M^{1-2} ; strong anteroposterior connection of the M_{1-3} entoconid and metaconid; and relatively anteroposterior M_{1-3} cristid obliqua.

Measurements. P^3 AP(4), mean 5.7, OR 5.4-5.9; BL(5), mean 3.9, OR 3.1-4.2, CV 11.5; HC(3), mean 3.1, OR 2.8-3.6. dP^4 AP(5), mean 5.2, OR 4.8-5.4, CV 5.0; BL(5), mean 5.6, OR 5.1-6.0, CV 8.2. P^4 AP(2), mean 4.8, OR 4.6-5.0; BL(1), 5.4; HC(1), 3.4. M^1 or M^2 AP(5), mean 5.9, OR 5.5-6.2, CV 5.1; BL(5), mean 7.5, OR 7.0-7.9, CV 5.3; HC(1), 3.5. P_3 AP(1), 4.9; BL(1), 1.9. dP_4 AP(2), mean 6.8, OR 6.6-6.9; BLtri(5), mean 2.6, OR 2.3-2.9, CV 8.8; BLtal(7), mean 2.9, OR 2.7-3.2, CV 5.5. P_4 HC(1), 3.1. M_1 or M_2 AP(5), mean 6.3, OR 5.8-6.8, CV 6.5; BLtri(13), mean 3.8, OR 3.7-4.8, CV 13.7; BLtal(9), mean 4.3, OR 3.3-5.0, CV 13.2. M_2 BLtal(1), 4.5. M_3 AP(3), mean 9.2, OR 8.4-10.1; BLtri(3), mean 4.5, OR 4.2-5.1; BLtal(2), mean 4.3, OR 4.2-4.4; HC(1), 4.3

Family Agriochoeridae

Protoreodon pumilus (Marsh, 1875)

Protoreodon parvus Scott and Osborn, 1887; Russell in Russell and Wickenden, 1933, p. 63.

Dichobunidae, genera and species undetermined, Russell, 1965a, p. 15 (in part).

Protoreodon parvus Scott and Osborn, 1887; Russell, 1965a, p. 15.

Material. RdP³, P1654.530-531; LP⁴, P1654.532-533; LM¹, P1654.534-535; RM¹, ROM 1702, ROM 23,591; LM², MMC 8664, P1654.536; RM², P1654.537; RP₂, P1589.16; LP₃, P1654.538; LP₄, P1654.539; LM₁ or M₂, ROM 1693, P1654.540-542; RM₁ or M₂, P1589.17-19, P1654.543; LM₃, ROM 35,032, P1530.7; RM₃, P1654.544.

Discussion. The material at hand exceeds published size ranges for Protoreodon pumilus (Gazin, 1955; Golz, 1976) for some elements, and falls below them for others. Swift Current specimens are about the size of P. pumilus and larger than P. parvus.

p⁴ (Fig. 10K) agrees with the diagnosis of P. pumilus (Golz, 1976, p. 34) in its weak but distinct separation of the paracone and metacone. Accordingly, I assign the entire sample to P. pumilus.

Measurements. dP³ BL(2), mean 7.6, OR 7.0-8.1. P⁴ AP(2), mean 7.4, OR 6.9-7.8; BL(1), 10.2. M¹ AP(3), mean 10.2, OR 9.1-10.7; BL(1), 10.4. M² AP(2), mean 11.9, OR 11.6-12.2; BL(2), mean 13.6, OR 13.2-14.0. P₂ AP(1), 7.6; BL(1), 3.8. P₃ AP(1), 8.1; BL(1), 4.2. M₁ or M₂ AP(1), 9.4; BLtri(1), 7.3; BLtal(3), mean 8.0, OR 7.7-8.2; HC(2), mean 5.2; OR 4.9-5.4. M₃ BLtri(1), 8.9; BLtal(1), 8.3

Family Protoceratidae

Leptoreodon marshi Wortman, 1898

Leptotragulus proavus Scott and Osborn, 1887; Russell in Russell and Wickenden, 1933, p. 64.

Leptotragulus proavus Scott and Osborn, 1887; Russell, 1965a, p. 16.

Leptotragulus medius Peterson, 1919; Russell, 1965a, p. 17.

Material. LP², P1654.545-547; RP², P1654.548-550; LdP³, P1643.3, P1654.551-554; RdP³, P1530.8, P1654.555-556; LP³, P1654.557-558; RP³, P1654.559; LdP⁴, P1654.560-562; RdP⁴, P1654.563-564; LP⁴, P1589.20, P1654.565; RP⁴, P1654.566; RM¹ or M², NMC 9156; LM¹, P1589.21, P1654.567-568; RM¹ ROM 1697, P1654.569-570; LM², P1654.571-574; RM², NMC 8669, ROM 1699, ROM 23,589, ROM 23,591, P1654.575-576; R maxillary fragment with M²⁻³, ROM 1698, P1654.577; LM³, NMC 8668, P1590.1, P1654.578-581; LP², P1589.22, P1654.582-583; RP², P1589.23-24, P1654.584-588; L mandibular fragment with P²⁻³, P1589.25; LdP³, ROM 35,027, P1654.591-596, P1654.602; RP³, P1589.26, P1654.597-601; LdP⁴, P1589.27, P1654.603-604; RdP⁴, P1654.605-607; R mandibular fragment with dP⁴-M³, ROM 1689; LP⁴, P1654.608-610; RP⁴, ROM 35,030, P1654.611-614; L mandibular fragment with M¹⁻², P1654.615; R mandibular fragment with M¹⁻², NMC 8666; R mandibular fragment with M²⁻³, P1589.28; LM¹ or M², P1562.1, P1654.616-621; RM¹ or M², NMC 8667, ROM 1700, P1589.29, P1654.622-625; RM³, ROM 1701, P1530.9.

Discussion. P₄ (Fig. 10L) is nearly identical with P₄ of the holotype of Leptoreodon marshi, AMNH 2064; the type P₄ is very worn, but is of the same size and occlusal shape, and shows the same strength and orientation of the metaconid. Many referred Leptoreodon P₄'s from other faunas are narrower, with weaker metaconid; all Swift Current examples have strong metaconids, though some are not as robust as in the figured specimen.

The sample at hand agrees well with the large series of measurements given by Wilson (1974), in the latest thorough study of L. marshi.

L. marshi is distinguished from Leptotragulus proavus by its large, anteriorly directed P_4 metaconid and perhaps by some minor characters (Gazin, 1955). If Leptoreodon and Leptotragulus are synonyms, as many authors suspect (Black, 1978, p. 247), Leptotragulus proavus is the senior name for the species.

Russell (1965a, p. 17) reported a comparatively small protoceratid tooth, and assigned it to Leptotragulus medius. The tooth is broken anteriorly, and I assume it originally had a strong parastyle and was not as short anteroposteriorly as it appears. The transverse diameter is well within the M^1 range of L. marshi.

Measurements. P^2 AP(1), 7.1; BL(2), mean 3.4, OR 2.9-3.9; HC(1), 4.4. dP^3 AP(3), mean 8.0, OR 7.9-8.1; BL(5), mean 5.5, OR 5.2-5.8, CV 4.7. P^3 AP(1), 8.3; BL(1), 5.9. dP^4 AP(1), 6.5; BL(1), 5.6. P^4 AP(2), mean 7.5, OR 7.3-7.6. M^1 AP(3), mean 6.5, OR 6.2-6.7; BL(2), mean 8.1, OR 7.7-8.5. M^2 AP(8), mean 8.1, OR 7.6-8.6, CV 7.5; BL(7), mean 10.4, OR 9.8-11.0, CV 4.0; HC(1), 4.9. M^3 AP(6), mean 8.5, OR 8.3-8.8, CV 2.1; BL(6), mean 11.7, OR 10.9-12.5, CV 5.2; HC(1), 5.7. P_2 AP(4), mean 5.7; OR 4.9-6.2; BL(5), mean 2.3, OR 2.0-2.5, CV 8.3; HC(3), mean 4.0, OR 3.3-4.7. dP_3 AP(2), mean 5.2, OR 5.0-5.3; BL(2), mean 2.1, OR 2.0-2.2. P_3 AP(7), mean 6.3, OR 5.5-7.3, CV 10.2; BL(10), mean 2.8, OR 2.4-3.9, CV 15.7; HC(2), mean 4.4, OR 4.1-4.7. dP_4 AP(2), mean 9.7, OR 9.4-10.0; BLtri(4), mean 4.5, OR 4.2-4.8; BLtal(2), mean 5.3, OR 5.3-5.3. P_4 AP(2), mean 7.2, OR 6.9-7.5; BL(5), mean 3.5, OR 2.9-4.1, CV 15.1; HC(1), 5.3. M_1 AP(2), mean 7.8, OR 7.2-8.4; BLtri(2), mean 5.5, OR 5.1-5.9; BLtal(2), mean 5.8, OR 5.3-6.3. M_2 AP(4), mean 8.3, OR 8.0-8.6; BLtri(3), mean 6.5, OR 6.0-6.8; BLtal(3), mean 6.7, OR 6.4-6.9. M_1 or M_2 AP(6), mean 8.0, OR 6.6-9.2, CV 11.6; BLtri(9), mean 5.5, OR 4.2-6.8, CV 18.4; BLtal(9), mean 5.9, OR 4.8-6.7, CV 14.2; HC(1), 4.6. M_3 AP(2), mean 12.8, OR 12.2-13.4; BLtri(3), mean 6.6, OR 6.5-6.7; BLtal(4), mean 6.3, OR 6.1-6.5; HC(1), 5.2.

Order Rodentia

Family Ischyromyidae

Leptotomus sp.

Paramys sp. Russell in Russell and Wickenden, 1933, p. 60.

Paramyid genus and species indeterminate, No. 4, Wood, 1962, p. 241.

Paramys? sp. Russell, 1965a, p. 9 (in part).

Ischyrotomus cf. I. compressidens (Peterson, 1919); Storer, 1978a, p. 1673.

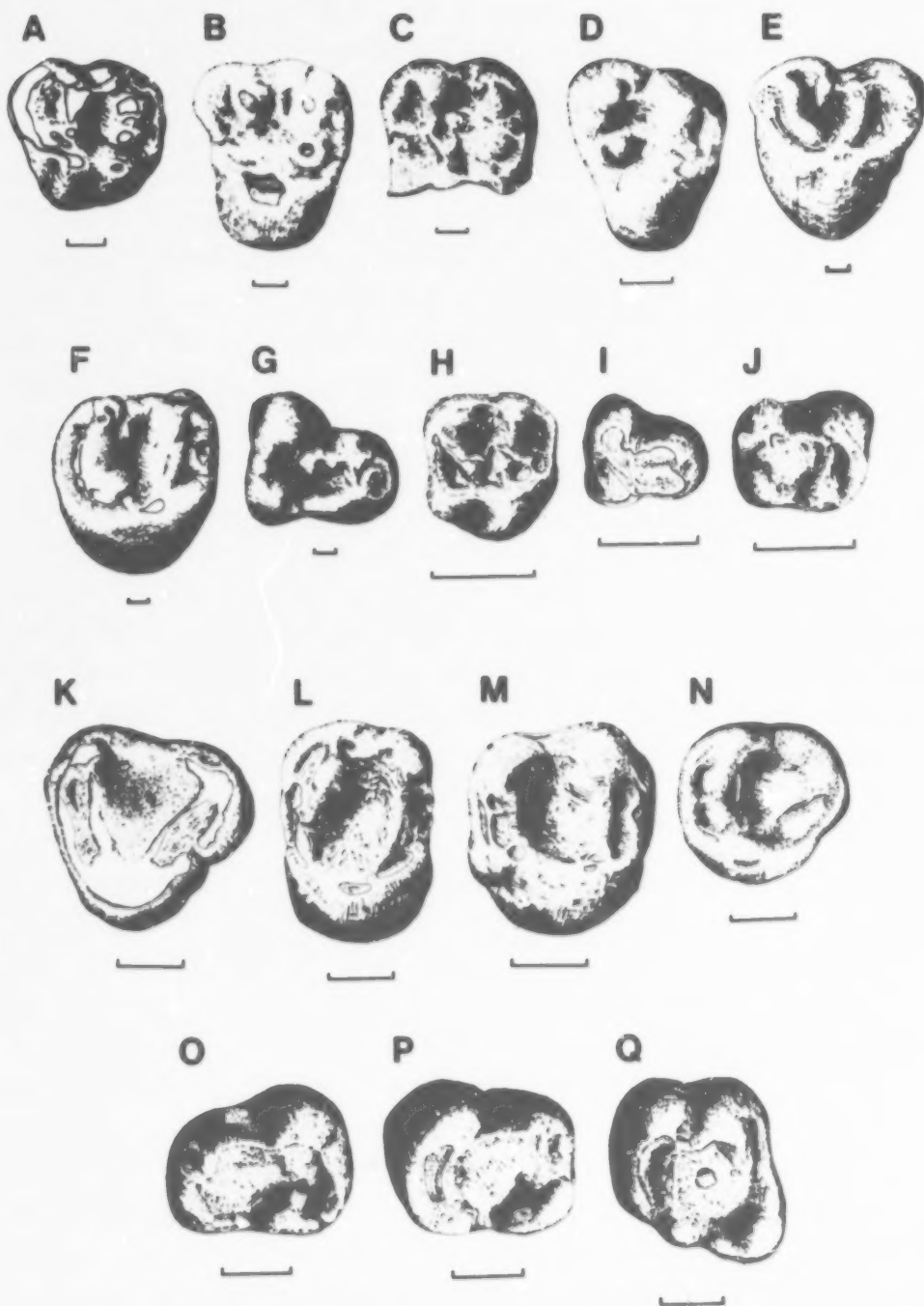
Material. LdP⁴, P1654.626; LP⁴, P1654.627; RP⁴, P1654.628; LM¹ or M², ROM 23,596, P1654.629-630; RM¹ or M², P1654.631; RdP₄, NMC 8652; LM₁ or M₂, P1530.1, P1654.632.

Description. Cheek teeth robust, low-crowned, shallow-patterned; enamel of basins slightly rugose. Upper cheek teeth with small hypocone giving rise to complete but low posterior cingulum; metacone large, bulbous.

dP⁴ (Fig. 11A) paracone triangular; protoconule low, single; protoloph directed anterolinguad, to anterior end of protocone; anterior cingulum complete, expanded, especially at parastyle; metaconule large, single; metaloph incomplete, directed toward hypocone; cusplule buccal to metacone, joining posterior cingulum; mesostyle oblique, moderately strong, attached to paracone, with short buccal cingulum from mesostyle to paracone.

P⁴ (Fig. 11B) protocone very large; protoconule single, small, with anterior connection to cingulum; protoloph nearly transverse, complete, attached to anterior end of protocone; anterior cingulum low lingually, rising to prominent parastyle; metaconule large, bulbous, close to posterior crown border, connected anterolingually near anterior end of hypocone, posterolingually to posterior cingulum; mesostyle large, connected to metacone.

Fig. 11. A-C, Leptotomus sp.; A, LdP^4 , P1654.626; B, LP^4 , P1654.627; C, LM^1 or M^2 , P1654.629. D, Leptotomus near L. guildayi, RP^4 , P1654.633. E-G Pseudotomus cf. P. eugenei; E, RdP^4 , ROM 23,594; F, RM^1 or M^2 , P1654.635; G, LdP^4 , P1654.637. H-J, Microparamys cf. M. dubius; H, RM^1 or M^2 , P1654.638; I, LP^4 , P1654.640; J, RM^1 or M^2 , P1654.645. K-Q, Microparamys solidus; K, RdP^4 , P1654.658; L, LP^4 , P1654.646; M, RM^1 or M^2 , P1654.652 (holotype); N, LM^3 , P1654.657; O, RP^4 , P1654.660; P, LM^1 or M^2 , P1654.662; Q, LM^3 , P1654.669. Anterior to left in A-C, J, L, N, O, to right in D-I, K, M, P, Q; buccal to top of page. Scales 1 mm.



M¹⁻² (Fig. 11C) poorly preserved; protocone elongate; protoconule indistinct with strong anterior connection to cingulum, weak spur toward anterior end of protocone; anterior cingulum incomplete, low lingually, rising to prominent parastyle; metaconule low, bulbous, not connected to hypocone, close to posterior crown border; short buccal spur from protocone extending into central basin; mesostyle large, made up of at least three cusps, attached to metacone; cuspsule buccal to metacone connected to posterior cingulum.

dP₄ and lower molars as described by Russell in Russell and Wickenden (1933, p. 60) and Storer (1978a).

Discussion. This material is referable to Leptotomus, because teeth show moderately large size; reduced, rugose basins; large, somewhat transverse entoconid; M¹⁻² lophs incomplete, lacking accessory cusps; hypocone weak in P⁴, moderately developed in M¹⁻²; and anterior cingulum migrating to buccal side of paracone. The mesoconid in the Swift Current M₁ or M₂ is indistinct, but L. leptodus also has a small mesoconid. Basins are shallower than in described species of Leptotomus. Size is as in L. grandis, but a number of differences in crown proportions, greater migration of the anterior cingulum buccal to the paracone, less strongly developed P⁴-M² hypocone, indistinct mesoconid in M₁₋₂, and entoconid strongly separated from the hypolophid distinguish the Swift Current form from that species.

Leptotomus leptodus offers more similarity than other described species, but the Swift Current form is smaller and shallower-patterned, and P⁴ has a smaller parastyle and stronger hypocone than L. leptodus.

dP₄ from the Swift Current sample is extremely transverse compared to dP₄ of L. grandis (Wood, 1962, fig. 25E), with a much stronger, anterobuccally expanded hypoconid. I refer the specimen to Leptotomus because of its size and shallow basin.

The sample appears to represent an undescribed species of Leptotomus characterized by shallow basins and a general appearance of massiveness.

Measurements. dP⁴ AP(1), 4.12; BL(1), 4.42. P⁴ AP(2), mean 4.55, OR 4.43-4.67; BL(2), mean 5.67, OR 5.56-5.78. M¹ or M² AP(2), mean 4.55, OR 4.42-4.68; BL(2), mean 5.23, OR 5.13-5.33; HC(1), 2.03. dP₄ AP(1), 4.2; BL(1), 4.3 (Russell in Russell and Wickenden, 1933). M₁ or M₂ AP(1), 4.50; BLmet(1), 3.95; BLhyp(1), 4.21.

Leptotomus near L. guildayi Black, 1971

Material. RP⁴, P1654.633.

Discussion. The only referred tooth (Fig. 11D) is nearly identical in occlusal pattern and size to Leptotomus near L. guildayi from early Badwater localities (Black, 1971, p. 191). The specimen is smaller than later L. guildayi from Badwater (op. cit.) and the Oligocene Calf Creek Local Fauna (Storer, 1978b).

Measurements. P⁴ AP(1), 3.12; BL(1), 3.72.

Pseudotomus cf. P. eugenei (Burke, 1935).

Dichobunidae?, genus and species indet. Russell in Russell and Wickenden, 1933, p. 63.

Mytonomys robustus (Peterson, 1919)?; Russell, 1965a, p. 10.

Dichobunidae, genera and species undetermined Russell, 1965a, p. 15 (in part).

Ischyrotomus cf. I. eugenei Burke, 1935; Storer, 1978a, p. 1674.

Material. RdP⁴, ROM 23,594; LP⁴, NMC 8662; LM¹ or M², P1654.634; RM¹ or M², ROM 1678, P1654.635-636; LdP₄, P1654.637; RP₄, P1530.2; RM₁ or M₂, NMC 9167.

Description. dP⁴ (Fig. 11E) crown as long as broad, subtriangular; parastyle very strong, extended anterobuccad; lophs, cingula, hypocone, mesostyle as in M¹⁻²

P⁴ illustrated by Russell (1965a, pl. 4, fig. 3); crown transverse; parastyle oblique, projecting anterobuccad; conules bulbous, without accessory cusps; mesostyle prominent, transverse; hypocone a strong posterior ridge from protocone; cingula very strong, complete around anterior, buccal, posterior crown border.

M¹ or M² (Fig. 11F) crown slightly transverse, occlusal surface nearly square in outline; hypocone a strong ridge not clearly separated from protocone; conules strong, single; protoloph complete, nearly transverse; metaloph curved, incomplete; mesostyle transverse; anterior, posterior cingula very strong but not continuing onto buccal face of crown.

dP₄ (Fig. 11G) metaconid larger than protoconid, set farther anterad, connected posteriorly by transverse ridge, anteriorly by strong cingulum to form closed trigonid basin; metaconid distinct, bulbous; hypoconid the size and height of protoconid, extended anterobuccad; entoconid separate from hypolophid, rounded, sending weak spur anterobuccad; metastylid low but distinct.

P₄ as described by Storer (1978a).

M₁ or M₂ as broad as long; enamel apparently rugose; hypolophid weak; posterolophid strong, complete; mesoconid moderately strong; metalophid complete; mesostylid distinct; anterior cingulum weak.

Discussion. I refer this material to Pseudotomus in agreement with a revision in press by W. W. Korth.

Although a much better sample is available from new collections, only M_1 or M_2 adds to earlier comparisons with the type material (Storer, 1978a). M_1 or M_2 is slightly smaller than corresponding teeth in the holotype, and agrees well in visible details. Therefore I retain the earlier identification.

P^4 and upper molars are of the approximate proportions and shapes of other Pseudotomus (including Ischyrotomus) (Wood, 1962, p. 200 ff.), but the strong buccal cingula of P^4 are not duplicated elsewhere in the genus. Size and crown height are equivalent to only P. eugenei and Manitsha tanka among Eocene-Oligocene rodents.

Teeth of the holotype of Oligocene Manitsha tanka are somewhat eroded, and the occlusal pattern appears weaker and shallower than it probably was. The Swift Current specimens have much stronger and more cusped lophs than in M. tanka, P^4 has a much stronger paracone and hypocone, and P_4 is far more transverse. Thus assignment to Pseudotomus rather than Manitsha seems justified, and the only described species showing close similarity is P. eugenei.

Measurements. dP^4 AP(1), 7.7; BL(1), 7.8. P^4 AP(1), 7.0; BL(1), 9.1. M^1 or M^2 AP(2), mean 7.9, OR 7.8-8.0. BL(2), mean 9.7, OR 9.3-10.1. dP_4 AP(1), 7.3; BLmet(1), 4.8; BLhyp(1), 6.2. P_4 AP(1), 7.8; BLmet(1), 6.5; BLhyp(1), 8.2. M_1 or M_2 AP(1), 7.9; BLmet(1), 8.0; BLhyp(1), 8.0.

Microparamys dubius (Wood, 1949).

Material. RM^1 or M^2 , P1654.638-639; LP_4 , P1654.640-642; RP_4 , P1654.643; LM_1 or M_2 , P1654.644; RM_1 or M_2 , P1654.645.

Discussion. This material corresponds excellently with Badwater and Uinta Basin material assigned to Microparamys dubius (Dawson, 1966, 1974), possibly showing a slightly larger hypoconid in M_{1-2} than in other described specimens.

As with Powder Wash Microparamys (Dawson, 1968), it is easy to confuse P_4 with material belonging to another taxon, in this instance the eomyid "Namatomys" fugitivus. I have attempted to be conservative in assignment of worn P_4 , which are very similar in size and occlusal shape. It is probable that I have misidentified some specimens, but I am confident that the number of teeth affected is small.

The rarity of M. dubius at Swift Current agrees with Dawson's hypothesis (1974, p. 149) that the genus' "distribution and extinction may have been related to development of the eomyids" Two eomyids of comparable size are abundant in the Swift Current Creek Local Fauna.

Measurements. M^1 or M^2 AP(2), mean 1.32, OR 1.30-1.33; BL(2), mean 1.51, OR 1.45-1.56; HC(2), mean 0.80, OR 0.78-0.82. P_4 AP(3), mean 1.31, OR 1.24-1.38; BLmet(3), mean 0.96, OR 0.90-1.02; BLhyp(3), mean 1.18, OR 1.15-1.21. M_1 or M_2 AP(2), mean 1.48, OR 1.40-1.56; BLmet(1), 1.13; BLhyp(2), mean 1.41, OR 1.32-1.50.

Microparamys solidus, sp. nov.

Paramys sp. Russell, 1965a, p. 9.

Reithroparamys sp. Storer, 1978a, p. 1673.

Type. Holotype RM^1 or M^2 , P1654.652.

Material. Holotype and RdP^4 , P1654.658; LP^4 , P1654.646; LM^1 or M^2 , P1654.647-651; RM^1 or M^2 , P1654.653-655; LM^3 , P1654.656-657; RM^3 , P1654.659; RP_4 , P1654.660-661; LM_1 or M_2 , P1654.662-665; RM_1 or M_2 , ROM 1677, P1654.666-668; LM_3 , P1654.669-670; RM_3 , P1654.671.

Diagnosis. Check teeth larger than in other described species; hypocone small or ridgelike, poorly separated from protocone; P^4-M^3 lophs relatively straight, complete; mesoconid absent in M_{1-2} , weak in P_4 , M_3 ; P_4-M_2 entoconid relatively far forward, hypoconid oblique; P^4 , M_3 relatively transverse.

Etymology. Latin solidus, massive.

Description. Cheek teeth very large for genus; small or ridgelike hypocone poorly separated from protocone; upper teeth with relatively straight, blunt, complete lophs converging on protocone; anterior and posterior cingula strong, high, blunt, not extending onto buccal face of crown; P^4-M^2 conules low, transverse, single.

dP^4 (Fig. 11K) worn; crown triangular, slightly broader than long; paracone, metacone near crown corners; cingula high, anterior cingulum incomplete; hypocone obliterated by wear but evidently poorly developed; mesostyle indistinct.

P^4 (Fig. 11L) transverse; parastyle small; mesostyle low but distinct, anteroposteriorly elongate; para- and metacone transverse.

M^{1-2} (Fig. 11M) nearly rectangular; mesostyle small; hypocone poorly developed but distinct, at posterolingual corner of crown; anteroposterior connections between metaloph and posterior cingulum.

M^3 (Fig. 11N) oval, nearly as broad as long; metacone weak, oblique; mesostyle barely distinguishable.

P_4-M_2 entoconid relatively far forward, strongly separated from posterolophid; hypoconid moderately developed, oblique.

P₄ (Fig. 110) elongate, narrow; mesoconid indistinct; metaconid anterobuccal to protoconid; short, curved anterior cingulum closing trigonid basin; meta- and mesostylid both present but weak; hypolophid incomplete, consisting of short spur from entoconid, weak spur from hypoconid.

M₁₋₂ (Fig. 11P; Russell, 1965a, pl. 1, fig. 4) nearly rectangular, slightly broader posteriorly than anteriorly; mesoconid, lingual styles lacking; all four lophids complete, strong.

M₃ (Fig. 11Q) nearly as broad as long; entoconid bulbous, relatively far forward; hypolophid complete, strong, transverse; metalophid strong but incomplete, forming high, transverse spur from protoconid; mesoconid small.

Discussion. Characteristics of M₁₋₂ previously led me to assign some of this material to Reithroparamys (Storer, 1978a). Although size is comparable to Reithroparamys rather than to previously described Microparamys, I assign the Swift Current sample to the latter genus because the complete lophids converge on the protocone in upper cheek teeth, and all cheek teeth approach a four-crested pattern to a greater degree than is typical in Reithroparamys.

Additional similarities to Microparamys include relatively shallow occlusal pattern, without sharp valleys in the major basins; and transverse P⁴.

Forward migration of the entoconid parallels a trend in late Reithroparamys (Wood, 1962, p. 139), as does strengthening of the hypolophid. Among described species of either genus, only the Oligocene Microparamys perfossus (Wood, 1974, p. 16) shows a complete (but variably developed) hypolophid: the feature is never as strong as in M. solidus.

A previously recognized species of equal size, M. wyomingensis, was reassigned to Paramys by West (1969). This upper Bridger species has a large, anteriorly extended parastyle in P^4 , and lophs of upper molars are incomplete with prominent conules, and do not converge lingually. I agree with West's exclusion of the material from Microparamys, but point out that M. solidus displays the characteristics of Microparamys that P. wyomingensis does not.

Measurements. dP^4 AP(1), 3.06; BL(1), 3.17. P^4 AP(1), 2.40; BL(1), 3.39. M^1 or M^2 AP(9), mean 2.59, OR 2.31-2.83, CV 6.6; BL(9), mean 2.99, OR 2.50-3.26, CV 9.9; HC(4), mean 1.73, OR 1.53-1.95. M^3 AP(2), mean 2.76, OR 2.67-2.84; BL(2), mean 2.50, OR 2.45-2.55. P_4 AP(1), 2.70; BLmet(1), 2.04; BLhyp(1), 2.21. M_1 or M_2 AP(7), mean 2.79, OR 2.62-3.20, CV 6.8; BLmet(7), mean 2.68, OR 2.36-2.96, CV 9.0; BLhyp(6), mean 2.76, or 2.46-3.13, CV 9.1. M_3 AP(2), mean 3.07, OR 2.80-3.34; BLmet(2), mean 3.27, OR 2.95-3.58; BLhyp(2), mean 2.70, OR 2.70-2.70.

Family Cylindrodontidae

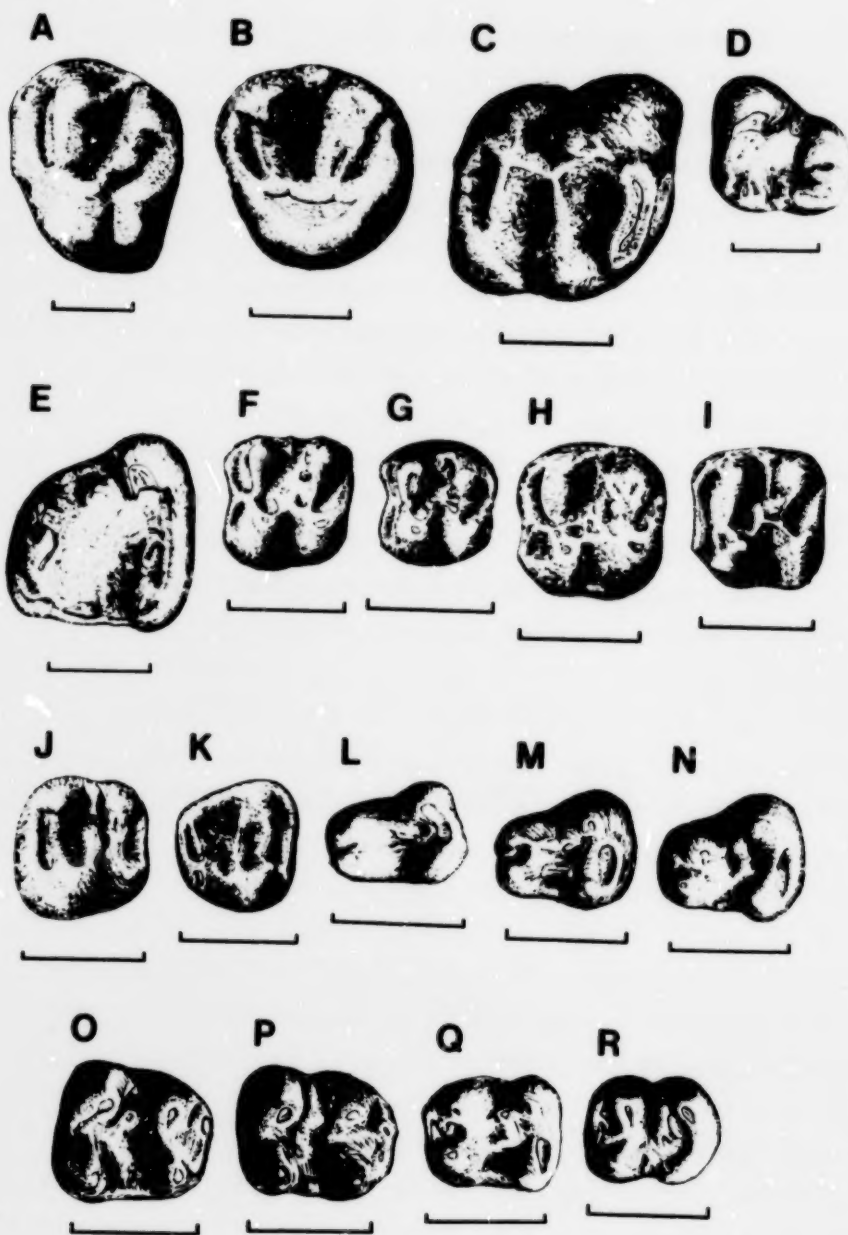
Pseudocylindrodon citofluminis, sp. nov.

Type. Holotype LM^1 or M^2 , P1654.672.

Material. Holotype and LM^1 or M^2 , P1654.673-674; LM^3 , P1654.675; LM_1 or M_2 , P1654.676; RM_1 or M_2 , P1654.677.

Diagnosis. Cheek teeth lower-crowned, shallower-patterned than in other species; M^{1-2} hypocone rounded, clearly set off from protocone; anterior basin of upper molars open; protoloph straight, transverse; metacone small, oblique; mesostyle variable, attached to paracone, not blocking central basin; M^3 transverse; M_{1-2} anterior basin broad, anteroposteriorly compressed; central, posterior basins open lingually; entoconid small, rounded.

Fig. 12. A-C, Pseudocylindrodon citofluminis; A, LM¹ or M², P1654.672 (holotype); B, LM³, P1654.675; C, RM, or M₂, P1654.677. D-E Prosciurinae, gen. et sp. indet.; D, LP₄, P1654.678; E, RM₁ or M₂, P1654.679. F-R, "Namatomys" fugitivus; F, LdP⁴, P1654.680; G, LP⁴, P1654.682; H, LM¹, P1654.690; I, LM¹, P1654.691; J, LM², P1654.712; K, RM³, P1654.725; L, RdP₄, P1654.728; M, RP₄, P1654.743 (holotype); N, RP₄, P1654.744; O, LM₁ or M₂, P1654.755; P, LM, or M₂, P1654.756; Q, RM, or M₂, P1654.790; R, RM₃, P1654.825. Anterior to left in A, B, E-J, L-N, Q, R, to right in C, D, K, O, P; buccal to top of page. Scales 1 mm.



Etymology. Latin citus, swift; Latin fluminis, of a current.

Description. Cheek teeth lower-crowned, shallower-patterned than in other Pseudocylindrodon, but advanced over Mysops.

M^{1-2} (Fig. 12A) nearly square in occlusal outline, slightly broader than long; hypocone rounded, clearly separated from protocone; protoloph complete, transverse, protoconule small, single, immediately buccal to protocone; metaloph complete, oblique, with single metaconule; mesostyle moderately developed, attached to paracone; central, anterior basins open buccally; metacone smaller than in other species, oblique.

M^3 (Fig. 12B) transverse, little-reduced relative to M^{1-2} ; hypocone not strongly separated from protocone; crown reduced posteriorly; other features as in M^{1-2} .

M_{1-2} (Fig. 12C) nearly rectangular in occlusal outline; only slightly broader posteriorly than anteriorly; entoconid relatively small, rounded; anterior basin broad, anteroposteriorly compressed, very shallow; central, posterior basins open lingually.

Discussion. This material is roughly comparable with Badwater Duchesnean Pseudocylindrodon tobeyi (Black, 1970), but is more primitive in several characters.

Noticeably lower crown height and shallower occlusal pattern differentiate P. citofluminis from all other Pseudocylindrodon species. Bridgerian Mysops parvus and M. fraternus are still lower-crowned and shallower-patterned, although I suspect that future discoveries will demonstrate gradation of Mysops into Pseudocylindrodon. An important difference from Mysops is the near equivalence of trigonid and talonid height in M_{1-2} . P. citofluminis differs from Pareumys and from the species of Mysops that are Pareumys' apparent ancestors (e.g., Mysops boskeyi, Wood, 1973) in the complete metaloph of its upper cheek teeth and the broad anterior basin and long, complete metalophid of M_{1-2} . On

the other hand, the rounded, distinct M^{1-2} hypocone, persistently open anterior basin of M^{1-3} and posterior basin of M_{1-2} , transverse, relatively unreduced M^3 , and small, rounded entoconid in P. citofluminis are more primitive characters than have been found in previously described Pseudocylindrodon, and are reminiscent of Mysops.

The anteroposteriorly compressed anterior basin of M_{1-2} is more similar to the Oligocene cylindrodontids, and may indicate that P. citofluminis and P. tobeyi were on different evolutionary pathways. Given the present evidence, it is not certain which species, if either, gave rise to Oligocene Pseudocylindrodon or Cylindrodon.

Among other cylindrodonts, Jaywilsonomys (Ferrusquia-Villafranca and Wood, 1969) shows an incomplete metaloph and metalophid, and is relatively high-crowned; and ?Pseudocylindrodon sp. (Black, 1970, p. 208) is larger, with incomplete metalophids, and has a transversely reduced M^3 with a distinctly different loph arrangement.

Measurements. M^1 or M^2 AP(2), mean 2.03, OR 1.88-2.18; BL(2), mean 2.35, OR 2.35-2.35; HC at protocone (1), 2.02. M^3 AP(1), 1.90; BL(1), 2.05. M_1 or M_2 AP(2), mean 1.99, OR 1.98-2.00; BLmet(2), mean 1.92, OR 1.80-2.03; BLhyp(2), mean 2.02, OR 1.92-2.11; HC(1), 1.51.

Family Aplodontidae

Prosciurinae, gen. et sp. indet.

Material. LP₄, P1654.678; RM₁ or M₂, P1654.679.

Description. P₄ (Fig. 120) metalophid and mesoconid strong, projecting anterobuccally from ectolophid; hypoconid very reduced, projecting anterobuccad; entoconid weakly separated from posterior cingulum; hypolophid incomplete, oblique; metastylid large.

Lower molar (Fig. 12E) much broader posteriorly than anteriorly; metalophid weak; anterior cingulum strong, transverse, apparently bearing anterobuccal cuspule; mesoconid strong, projecting anterobuccad but not linguad from ectolophid; hypoconid relatively small, projecting anterobuccad; entoconid only weakly separated from posterior cingulum; hypolophid oblique, connecting with posterior cingulum near middle of crown; metastylid area worn or broken.

Discussion. These teeth show closest affinities to the prosciurine aplodontids, with their weak hypoconids, restricted and reduced trigonid basins, large mesoconids, and strong hypolophid in the lower molar. Size differences indicate that the specimens may not be referable to the same species, and the lower molar has an extremely large and deep talonid basin, with thin, straight posterolophid. Otherwise, the specimens have similar occlusal features and crown height.

In no described prosciurine is the M_{1-2} trigonid as reduced transversely as in the Swift Current specimen, and this feature indicates that a new genus is represented. Prosciurus vetustus (Black, 1965, fig. 1a) is somewhat similar in P_4 pattern, and M_1 has a relatively long, straight posterolophid, oblique hypoconid and hypolophid, large, triangular mesoconid, and buccal shelf beneath the mesoconid, but the metalophid is incomplete. Among other prosciurines, Prosciurus relictus (Wood, 1962, fig. 85C) is less similar, with less oblique hypoconid, complete hypolophid, and incomplete metalophid in M_1 ; and P. saskatchewanensis is not a prosciurine, at least the holotype representing a large cylindrodontid, probably Ardynomys (Storer, 1978b).

Complete metalophids with reduced trigonid basins appear in Spurimus (Black, 1971), Cedromus wardi (Wood, 1962, fig. 86A), ?Protosciurus jeffersoni [Black, 1965, fig. 1c: Black (1965) and Storer (1978b) placed this taxon in the Sciuridae, Wood (1962, 1980) in Cedromus, among the prosciurines; Galbreath (1953, p. 59) assigned all Cedromus to the Sciuridae], and Pelycomys (Galbreath, 1953). All these taxa

have less oblique hypoconids and transverse hypolophids. Some transverse reduction of the M_{1-2} trigonid occurs in Pelycomys placidus and Spurimus.

Measurements. P_4 AP(1), 1.56; BLmet(1), 1.29; BLhyp(1), 1.47. M_1 or M_2 AP(1), 1.81; BLmet(1), 1.75; BLhyp(1), 2.00.

Family Eomyidae

"Namatomys" fugitivus, sp. nov.

Type. Holotype RP_4 , P1654.743.

Material. Holotype and LdP^4 , P1654.680; RdP^4 , P1654.681; LP^4 , P1654.682-687; RP^4 , P1654.688-689; LM^1 , P1654.690-698; RM^1 , P1654.699-710; LM^2 , P1654.711-718; RM^2 , P1654.719-724; RM^3 , P1654.725-726; LdP_4 , P1654.727; RdP_4 , P1654.728-730; LP_4 , P1654.731-742; RP_4 , P1654.744-754; LM_1 or M_2 , P1654.755-782; RM_1 or M_2 , P1654.783-820; LM_3 , P1654.821-824; RM_3 , P1654.825-835.

Diagnosis. Cheek teeth average slightly smaller than in "Namatomys" fantasma; buccal cusps in upper teeth, lingual cusps in lower teeth lower, less massive; valleys rounded, not sharp; lophs/lophids low but crested; P^4-M^2 with higher frequency of posterior protoloph-paracone connection than in "N." fantasma; P^4 nearly square; M^1 not markedly transverse; M^3 with both metaloph and posteroloph; lower teeth with weak or interrupted ectolophids; mesolophid in M_{1-3} tending to extend linguad as a forked, strong element.

Etymology. Latin fugitivus, fugitive, referring to the occurrence of this species far from reported congeners.

Description. Teeth slightly lower-crowned than in Adjidaumo; protocone/protoconid, hypocone/hypoconid reduced, oblique; lophs, lophids low, slender, crested; metacone of P^4-M^2 , entoconid of P_4-M_2 sharp, anteroposteriorly compressed.

P^4 (Fig. 12G) nearly square in occlusal outline; major cusps of about equal size, height; anterior arm of protocone, hypocone connected nearly transversely to buccal cusps; central mure curved buccally, joining protocone, hypocone; mesostyle small to moderate; anterior cingulum short, free lingually, strong, complete buccally, joined near middle of tooth to anterior arm of protocone; posterior cingulum strong, curved posterad, from hypocone to posterobuccal face of metacone. Variants: of 7 well-preserved specimens, central mure incomplete in 3; anterior spur from metacone, metaloph into central valley in 4; weak but apparently complete mesoloph in 2; anterior cingulum weak or absent lingually in 3; anterior cingulum entirely lacking in 1; protolophule II joining paracone in 4; metaloph joining central mure rather than hypocone in 1.

Presumed dP^4 (Fig. 12F) as P^4 , but slightly lower-crowned, anterior cingulum more projected anterad. Mure complete; metaloph with spurs; mesostyle strong in both specimens; mesocone evident in one; anterior cingulum absent lingually but very strong buccally in one.

M^{1-2} separated following Lindsay (1968, pp. 8-9); M^1 (Figs. 12H,I) subrectangular, longer than wide or slightly wider than long; M^2 (Fig. 12J) subrectangular, distinctly wider than long; specimens in the present sample form distinct but not sharply separate groups by comparative length-width measurements.

M^{1-2} basic pattern with protoloph, metaloph connecting transversely or slightly posterolingually with anterior arms of protocone and hypocone; central mure curved buccad, connecting protocone, hypocone; anterior cingulum traversing nearly entire crown, free lingually, connected to anterior arm of protocone; posterior cingulum strong, from hypocone to posterobuccal base of metacone; mesostyle distinct; mesocone very weak.

M¹ variants: of 18 well-preserved specimens, central mure incomplete in 3; anterior spurs from metaloph in 5; anterior cingulum weak linguallly in 5; protolophule II meeting paracone in 3; mesoloph low but complete in 12; minor ridges, cross-connections in central basin in 1.

M² variants: of 12 well-preserved specimens, central mure incomplete in 5; anterior spurs from metaloph in 4; anterior cingulum weak or absent linguallly in 5; protolophule II meeting paracone in 3; mesoloph low but complete in 5; anterior cingulum not connected to anterior arm of protocone in 1.

M³ (Fig. 12K) known from only one well-preserved example; protocone, protoloph, paracone, anterior cingulum as in M¹⁻²; hypocone, metacone subequal, very reduced, connected by low, oblique metaloph; posterior cingulum complete, as high as metaloph; mesocone lacking; mesostyle well-defined, buccolingually compressed; central valley with complex spurs, accessory ridges from protocone, metaloph.

In P₄-M₂, hypolophid reaching posterobuccad from entoconid to join short posterior arm of hypoconid; posterior cingulum strong, reaching from hypoconid-hypolophid connection to entoconid; ectolophid reaching nearly anterad from hypoconid, connecting with protoconid; mesoconid distinct, normally bulbous, with low extensions buccally and into talonid basin; metalophid curved posterad, connecting protoconid, metaconid posteriorly; talonid basin weakly rugose.

P₄ (Figs. 12M,N) narrower anteriorly than posteriorly; metalophid very short, trigonid basin very small, buccal to middle of crown; small, low anteroconid at anterior end of trigonid basin. Variants: of 18 well-preserved specimens, ectolophid incomplete in 4; anteroconid with ridges to base of protoconid in 3, to metaconid in 4; metastylid distinct in 11; mesoconid transverse, sharp buccally and forming incipient mesolophid linguallly in 5; posterior spurs from metalophid in 8; anteroconid absent in 2.

dF₄ (Fig. 12L) pattern as in P₄, but lower-crowned, proportionally narrower.

M₁₋₂ (Figs. 120-Q) rectangular to subrectangular; anterior cingulum traversing entire width of crown, free buccally, connected to base of metaconid lingually, connected to anterior arm of protoconid; anteroconid (sensu Lindsay, 1968) bulbous, standing slightly above anterior cingulum.

M₁₋₂ not clearly separable, though more anteroposteriorly elongate teeth with anterior cingulum projecting well anterad and metalophid more markedly curved posterad are probably M₁; and less anteroposteriorly elongate teeth with flatter anterior crown border and more transverse metalophid are probably M₂: many teeth do not fit clearly into one group or the other.

M₁₋₂ variants: of 52 well-preserved specimens, ectolophid incomplete in 20; mesoconid transverse, sharp buccally and forming incipient mesolophid lingually in 19; metastylid distinct in 27; anterior cingulum not free buccally in 8; anterior cingulum not joined to anterior arm of protoconid in 16; anterior arm of protoconid weakly joined to anterobuccal face of metaconid in 20; enlargement (hypoconulid?) posterolingual to hypoconid in 8.

M₃ (Fig. 12R) with markedly convex posterior border; hypoconid nearly submerged in hypolophid; entoconid barely rising above hypolophid; posterior cingulum lacking; protoconid-metaconid connection relatively transverse, only slightly curved posterad; anterior cingulum traversing nearly entire crown, free buccally, joined weakly to metaconid base, weakly connected to anterior arm of protoconid; metastylid distinct. Variants: of 12 well-preserved specimens, ectolophid incomplete in 9; metastylid indistinct in 1; mesoconid transverse, sharp buccally, forming incipient mesolophid lingually in 8; anterior cingulum not free buccally in 3; anterior cingulum not joined to anterior arm of protoconid in 6; anterior arm of protoconid weakly joining metaconid in 4.

Discussion. This material does not belong in Namatomys: I refer it to that genus as a nomenclatural convenience, in order not to interfere with work done by John J. Chiment (1977), which he is preparing for publication. Chiment will propose a new genus for "Namatomys" fantasma Lindsay, 1968, and two new species from the later Eocene of southern California. "Namatomys" fugitivus is referable to Chiment's new genus, and is clearly different from all three California species.

As Wood (1980, p. 40) pointed out, Namatomys lloydi Black, 1965, has much higher-crowned teeth than Adjidaumo: "Namatomys" fantasma, "N." fugitivus, and Chiment's new species are slightly lower-crowned than Adjidaumo. Fahlbusch (1973, p. 147), without seeing the original specimens, thought "N." fantasma was quite different from N. lloydi, pointing out the lack of a doubled protoconid-metaconid connection, ectolophid often incomplete, and mesolophid somewhat isolated.

Similarities between Namatomys lloydi and the Eocene species are based on retention of primitive characters: in lower teeth, reduced, oblique protoconid and hypoconid, and relatively oblique, curved protoconid-metaconid connections. N. lloydi could be descended from the Eocene taxa, but dissimilarities in detail are too great for any close relationship to be proven.

I agree with Lindsay (1968) that "N." fantasma (and its relatives) are eomyids, but not because of the apparent absence of P^3 . I too can find no appression facet on the anterior margin of P^4 , but Dawson (1968, p. 355) has established that at least one sciuravid, Pauromys sp. from the early Bridgerian of Utah, probably lacked P^3 .

Both the Swift Current and Sespe taxa show eomyid-like P^4 's, relatively square in occlusal outline, with direct metaloph-hypocone connections: in sciuravids, P^4 is oval, with the metaloph connecting to the protocone. P_4 is also typically eomyid in pattern, with a relatively rectangular shape and subequal protoconid and hypoconid, but some sciuravids (e.g., Sciuravus eucristadens, Dawson, 1968, fig. 21) are similar.

"Namatomys" was not descended from any known Bridgerian sciuravid. Among Bridgerian genera, only Pauromys is low-crowned enough to be an ancestor, but known Pauromys species show marked reduction of P_4 , while in "Namatomys" P_4 is large and elongate. Only the Wasatchian Knightomys depressus (Wood, 1965), the most primitive known sciuravid, offers possibilities as an ancestral form: intermediates are not known.

Direct derivation from microparamyine ischyromyids is another possibility, but would have involved a great deal of undocumented change. Reduced, anterobuccally-directed protoconids and hypoconids are found in both groups, for example, but many dissimilarities appear, including the relative positions and connections of cusps in M^{1-2} .

"N." fugitivus itself may have represented a different evolutionary lineage from that seen in California. It roughly parallels "N." fantasma, but differs in its low but crested lophs and lophids, subequal major cusps (in "N." fantasma the protocone-protoconid and hypocone-hypoconid are larger and higher), and prominent, forked mesolophids of M_{1-3} . One of the new southern California species is more similar to "N." fugitivus, but is slightly smaller, with differences in tooth shapes, anterior cingulum development, and cusp connections.

Measurements. dP^4 AP(1), 1.09; BL(2), mean 1.22, OR 1.04-1.40. P^4 AP(7), mean 1.01, OR 0.92-1.05, CV 5.0; BL(7), mean 1.04, OR 1.00-1.08, CV 1.9; HC at protocone(1), 0.55. M^1 AP(20), mean 1.16, OR 1.08-1.24, CV 4.3; BL(14), mean 1.17, OR 1.06-1.28, CV 6.0; HC at protocone(5), mean 0.68, OR 0.62-0.74, CV 8.1. M^2 AP(13), mean 1.09, OR 1.00-1.15, CV 3.4; BL(10), mean 1.24, OR 1.17-1.29, CV 3.2; HC at protocone(3), mean 0.70, OR 0.66-0.75. M^3 AP(2), mean 0.98, OR 0.93-1.02; BL(2), mean 1.11, OR 1.10-1.11. dP_4 AP(4), mean 0.98, OR 0.90-1.05; BLmet(3), mean 0.68, OR 0.67-0.69; BLhyp(3), mean 0.80, OR 0.78-0.82. P_4 AP(21), mean 1.10, OR 0.96-1.26, CV 7.3; BLmet(17), mean 0.82, OR 0.69-0.99, CV 8.5; BLhyp(19), mean 0.96, OR 0.83-1.14, CV 7.3; HC(3), mean 0.73, OR 0.66-0.78. M_1 or M_2 AP(55), mean 1.16, OR 0.96-1.30, CV 6.0;

BLmet(60), mean 1.05, OR 0.92-1.29, CV 7.6; BLhyp(58), mean 1.08, OR 0.94-1.28, CV 6.5; HC(12), mean 0.64, OR 0.58-0.68, CV 4.4. M_3 AP(13), mean 1.11, OR 0.99-1.16, CV 5.4; BLmet(13), mean 0.99, OR 0.95-1.05, CV 3.0; BLhyp(14), mean 0.93, OR 0.84-1.05, CV 6.5.

Protadjidaumo altilophus, sp. nov.

Type. Holotype RM_1 , P1654.862.

Material. Holotype and LdP^4 , P1654.836; LP^4 , P1654.837-838; RP^4 , P1654.839; LM^1 , P1654.840; RM^1 , P1654.841-842; LM^2 , P1654.843-844; RM^2 , P1654.845-849; LM^3 , P1654.850; RM^3 , P1654.851; LdP_4 , P1654.852-853; LP_4 , P1654.854-857; RP_4 , P1654.858-859; LM_1 , P1654.860-861; RM_1 , P1654.863; LM_2 , P1654.864.

Diagnosis. Cheek teeth slightly larger, higher-crowned than in Protadjidaumo typus; lophids thick, high; M_1 less anteroposteriorly elongate than in P. typus; P_4 - M_2 posterior cingulum not developed buccally.

Etymology. Latin altus, high; lophus, Latinized version of loph.

Description. Cheek teeth slightly higher-crowned than in Protadjidaumo typus. Cheek teeth appear relatively bulbous in side view; lophs, lophids high, thick; basins deep; major cusps of P_4 , M_1 - M_2 subequal in size, height.

P^4 (Fig. 13B) nearly square in occlusal outline; anterior cingulum lacking (faint trace of buccal portion in one of three specimens); paracone oblique; metaloph connected to anterior arm of hypocone; mesoloph oblique, connecting to posterolingual base of paracone; central mure nearly anteroposterior, complete; posterior cingulum strong, complete from hypocone to posterior margin of metacone.

Fig. 13. A-J Protadjidaumo altilophus; A, LdP⁴, P1654.836; B, LP⁴, P1654.837; C, LM¹, P1654.840; D, RM¹, P1654.841; E, LM², P1654.844; F, LM³, P1654.850; G, LdP₄, P1654.852; H, RP₄, P1654.858; I, RM₁, P1654.862 (holotype); J, LM₂, P1654.864. K-P, Janimus mirus; K, LP⁴, P1654.864; L, LM¹ or M², P1654.869; M, LM¹ or M², P1654.871; N, LM³, P1654.877, O, RM₁ or M₂, P1654.882 (holotype); P, LM₃, P1654.888. Anterior to left in A-C, E, F, H, I, K-O, to right in D, G, J, P; buccal to top of page. Scales 1 mm.



Presumed dP^4 (Fig. 13A) similar, but relatively longer anteroposteriorly, with prominent, anteriorly projected anterior cingulum.

M^{1-2} rectangular, probable M^1 (Fig. 13C,D) elongate anteroposteriorly, M^2 (Fig. 13E) transverse. Protoloph, metaloph connecting nearly transversely with anterior arms of protocone, hypocone; anterior, posterior cingula strong, not expressed lingually; mesoloph low, terminating in central basin; central mure curved buccad; paracone slightly oblique; mesostyle small but well defined; central basin slightly deeper anterior to mesoloph.

M^2 anterior cingulum much longer than in M^1 , arising from anterior face of protocone: M^1 anterior cingulum arising from protoloph-protocone junction. One M^2 with tiny lingual projection of anterior cingulum.

M^3 (Fig. 13F) as M^{1-2} , but with reduced metacone, metaloph connecting anterolingual to anterior arm of hypocone, crown narrower posteriorly than anteriorly, M^3 as transverse as M^2 .

P_4-M_2 posterior cingulum expressed only lingually, relatively short; mesolophid sloping, terminating in talonid basin; talonid basin deepest posterior to mesolophid, markedly displaced toward posterior crown border; metastylid indistinct.

P_4 (Fig. 13H) generally triangular; small trigonid basin isolated between metaconid, protoconid; hypolophid short, oblique, connected to posterior arm of hypoconid; metalophid very short, transverse; mesolophid directed posterolingual.

dP_4 (Fig. 13G) as P_4 , but relatively narrow; ectolophid incomplete; one specimen with prominent anteroconid, roughly rectangular shape; figured specimen with compressed anterior lophid, triangular shape.

Presumed M_1 (Fig. 13I) more anteroposteriorly elongate than M_2 (Fig. 13J). Anterior cingulum long, lingually short, free buccally, connected posteriorly to protoconid; metalophid nearly transverse; in one M_1 , mesolophid very long, sloping into talonid basin, otherwise mesolophids short. Hypolophid short, oblique in M_2 , anterior cingulum not connected to protoconid.

Discussion. Protadjidaumo altilophus differs from P. typus Burke (1934a) in many respects. Despite its greater age, P. altilophus represents a closer approach to Paradjidaumo, with its greater crown height; higher lophs and cingula; and less anteroposteriorly elongate lower molars with anterior cingula connected directly to the protoconid and short buccally, and posterior cingula short and not developed buccally. Upper cheek teeth also suggest a close relationship; P^4 lacks the anterior cingulum and is somewhat reduced anterobuccally; and M^{1-2} are nearly square, with high lophs, the anterior cingulum poorly developed lingually and the posterior cingulum running directly buccad from the hypocone. P. altilophus represents an ideal ancestral form for Paradjidaumo.

Neither P. typus nor P. altilophus can be close to the ancestry of Adjidaumo. As Black (1965, p. 39) observed, P. typus is higher-crowned than Adjidaumo, with stronger lophids: these characteristics are even more strongly developed in P. altilophus. Moreover, both P. typus and P. altilophus have posteriorly displaced talonid basins in P_4-M_2 , allying them with Paradjidaumo but not Adjidaumo.

Measurements. dP^4 AP(1), 1.09; BL(1), 0.94. P^4 AP(3), mean 1.01, OR 0.97-1.08; BL(3), mean 1.06, OR 1.02-1.10; HC at protocone(1), 0.72. M^1 AP(3), mean 1.20, OR 1.19-1.21; BL(3), mean 1.18, OR 1.12-1.21; HC at protocone(1), 0.85. M^2 AP(7), mean 1.13, OR 1.04-1.20, CV 4.4; BL(7), mean 1.27, OR 1.16-1.37, CV 5.5; HC at protocone(1), 0.87. M^3 AP(2), mean 0.96, OR 0.90-1.02; BL(2), mean 1.12, OR 1.05-1.19. dP_4 AP(2), mean 0.98, OR 0.94-1.01; BLmet(2), mean 0.69, OR 0.66-0.72; BLhyp(2), mean 0.85, OR 0.83-0.87. P_4 AP(6), mean 1.10, OR 1.03-1.23, CV 7.3; BLmet(5), mean 0.81, OR 0.78-0.87, CV 4.9; BLhyp(5), mean 0.97, OR

0.93-1.02, CV 3.1; HC(1), 0.87. M_1 AP(3), mean 1.12, OR 0.98-1.29; BLmet(3), mean 1.01, OR 0.90-1.14; BLhyp(4), mean 1.10, OR 0.96-1.23; HC(1), 0.81; HC at hypoconid(1), 0.90. M_2 AP(1), 1.21; BLmet(1), 1.20; BLhyp(1), 1.21.

Family ?Eutypomyidae

Janimus mirus, sp. nov.

Type. Holotype RM_1 or M_2 , P1654.882.

Material. Holotype and LP^4 , P1654.865-866; RP^4 , P1654.867-868; LM^1 or M^2 , P1654.869-873; RM^1 or M^2 , P1654.874-875; LM^3 , P1654.876-877; LM_1 or M_2 , P1654.878-881; RM_1 or M_2 , P1654.883-887; LM_3 , P1654.888-891; RM_3 , P1654.892.

Diagnosis. Cheek teeth smaller than in Janimus rhinophilus; M_{1-3} with lower, less massive, more crested lophids, more transverse metalophid, less anteroposterior metastylid.

Etymology. Latin mirus, extraordinary.

Description. P^4 (Fig. 13K) nearly square in occlusal outline, anterior border sharply notched; anterior, posterior cingula joined to bases of paracone, protocone, metacone, to tip of hypocone; mesostyle low, transverse; metacone joined by transverse, high ridge to anterior end of hypocone; paracone joined by low protolophules to both ends of protocone; anterior arm of protocone joins middle of anterior cingulum; enamel of central basin heavily rugose.

M¹⁻² (Fig. 13L,M) nearly square in occlusal outline; posterior arm of protocone not always joining metacone; anterior cingulum traversing nearly entire width of crown, attached near lingual end to anterior arm of protocone. Variants with metastyle reaching far linguad, central basin less rugose, central mure incomplete.

M³ (Fig. 13N) represented by poorly preserved specimens; tooth compressed anteroposteriorly; metacone apparently reduced; hypocone absent(?).

M₁ or M₂ (Fig. 13O) metaconid, entoconid subequal, higher than protoconid, hypoconid; lophids strong, crested, curved posterad; ectolophid incomplete; mesoconid transverse, extended strongly posterolinguad into central basin, forked linguallly; metastylid distinct, conical; posterobuccal spur of metaconid strong; anterior cingulum traversing nearly entire crown width, with strong posterolingual spur toward buccal arm of metaconid; anterior cingulum and its spur separated from protoconid by deep valley; posterior cingulum short, from hypoconid-entoconid junction to base of entoconid, enclosing small posterolingual valley; enamel of basins distinctly rugose.

M₃ (Fig. 13P) entoconid low, joined to posterior cingulum; lingual arm of protoconid long; enamel of basins heavily rugose; mesoconid weakly joined to buccal side of hypoconid; metastylid anteroposteriorly elongate.

Discussion. Lower molars are smaller than in Janimus rhinophilus (Dawson, 1966, p. 102), and are very similar in pattern, distinguished by lower, less massive, crested lophids and a curved but more transverse metalophid.

Dawson (op. cit., p. 107) suggested that Janimus might be related to primitive eutypomyids, and Wood (1974, pp. 95-96) pointed out similarities to Eutypomys inexpectatus.

Addition of upper cheek teeth to the sample does not weaken the possibility of eutypomyid relationship. Using the imagination freely, one can postulate derivation of E. inexpectatus from Janimus with strengthening of the mesoloph/mesolophid and extreme deepening of occlusal pattern. The major cusps of Janimus cheek teeth are in appropriate positions, with the protocone-protoconid and hypocone-hypoconid moved well in from the crown border, and the M^{1-2} protocone well posterad of the anterior border. Accessory ridges are numerous in both upper and lower cheek teeth, and would form a complex Eutypomys pattern if they were as high as the major lophs. Moreover, as Wood (1974) pointed out, the lower incisor of Janimus is less compressed transversely than that of Eutypomys, but there is a general similarity.

The occlusal patterns of Janimus show reasonable similarity to the Eomyidae, particularly to the complex but lower-crowned "Namatomys". The incisor of Janimus, with its rounded cross-sectional shape and weak anteromedial corner, appears to exclude the genus from the Eomyidae.

Upper tooth patterns show strong differences from the Ischyromyidae and Sciuravidae: one would not expect such a strong approach to a five-crested pattern in either group.

Thus I refer Janimus to the Eutypomyidae with serious reservations. If Janimus is referable to any of the recognized rodent families, the eutypomyids offer the only reasonable similarities. Wood (1974, p. 96) had similar misgivings about a direct Janimus-Eutypomys relationship, and Wahlert (1977, p. 6) admitted the possibility but pointed out that cranial material of Janimus, needed for confident reference to family, is unknown.

Measurements. P^4 AP(3), mean 1.39, OR 1.31-1.44; BL(4), mean 1.48, OR 1.41-1.57; HC at protocone(1), 0.81. M^1 or M^2 AP(7), mean 1.41, OR 1.34-1.54, CV 5.0; BL(6), mean 1.55, OR 1.40-1.68; CV 7.1; HC at protocone (2), mean 0.91, OR 0.88-0.93. M^3 AP(1), 1.19; BL(1), 1.28. M_1 or M_2 AP(7), mean 1.41, OR 1.26-1.58, CV 9.2; BLmet(9), mean 1.31,

OR 1.18-1.44, CV 7.6; BLhyp(8), mean 1.35, OR 1.20-1.50, CV 7.4. M_3
AP(5), mean 1.44, OR 1.39-1.50, CV 3.5; BLmet(5), mean 1.29, OR 1.25-
1.35, CV 3.1; BLhyp(5), mean 1.18, OR 1.16-1.20, CV 1.7.

Order Lagomorpha

Family Leporidae

Genus Procaprolagus Gureev, 1960

Type species. Procaprolagus vetustus (Burke, 1941), Ulan Gochu,
Mongolia; lower Oligocene.

Included North American species. Procaprolagus vusillus, sp. nov.,
Swift Current Creek Local Fauna, Saskatchewan; Uintan. Procaprolagus
gazini (Burke, 1936), Badland Creek, Nebraska; Orellan.

Emended diagnosis. Foramen premolare absent; all cheek teeth rooted,
lower-crowned than in Mytonolagus; P^3-M^2 hypostria, crescentic valley,
buccal pattern persisting into very late wear; P_3 , M_3^3 reduced; I_1
extending to posterior end of M_2 ; P_3 with anteroposteriorly short
talonid, very persistent lingual valley and anterolingual fold. P_4-M_2
talonid rounded, longer than trigonid, centered behind trigonid;
trigonid anteroposteriorly compressed; talonid, trigonid showing little
or no tendency to form lingual enamel bridge in late wear, lingual
folds persisting nearly to base of crown; P_4 only slightly narrower
than M_{1-2} .

Discussion. Gureev (1960) erected the genus Procaprolagus for
Desmatolagus vetustus and three new Mongolian Oligocene species. Sych
(1975) synonymized all but P. vetustus with Desmatolagus gobiensis,
considering the various species to be based on different wear stages
rather than on specifically significant characters.

I have not studied the Asian material sufficiently to judge the full scope of Procaprolagus and Desmatolagus in the Old World.

Desmatolagus' type species is D. gobiensis, which has the premolar foramen: Procaprolagus vetustus lacks the premolar foramen, and is at least technically a leporid, while Desmatolagus is an ochotonid.

Desmatolagus gobiensis, moreover, has higher-crowned cheek teeth than P. vetustus; P^3 with two free buccal roots, but the anterobuccal root originating beneath a dorsally extended enamel border; P_3 with lingual and anterolingual valleys less persistent; and P_4 - M_2 talonids less rounded and about as long as the trigonids, posterolophids less persistent, and talonid-trigonid forming lingual enamel bridges in late wear.

Thus Procaprolagus and Desmatolagus are clearly separate genera, and based on the presence or absence of the premolar foramen appear referable to different families.

The Swift Current species is strikingly similar to P. vetustus. Another similar taxon is Procaprolagus gazini, Orellan of Nebraska, known only from its holotype maxilla with P^3 - M^2 , CM 37. P. gazini is larger than P. vetustus and the Swift Current species, with the anterobuccal corner of P^3 more massive and rounded, and the M^{1-2} hypostria perhaps less persistent. Judging from the alveolus, M^3 was reduced to about the same degree as in P. vetustus and P. vusillus. P^3 in P. gazini has two free buccal roots, starting at the same level. The premolar foramen is lacking. Crown heights and curvature of upper molars are similar to P. vetustus and P. vusillus, and occlusal patterns are very persistent. Additional material of P. gazini is badly needed, but I have no doubt of its correct generic allocation.

Procaprolagus is quite different from Mytonolagus, and represents a separate lineage of lagomorphs. Mytonolagus has slightly higher-crowned teeth, a single buccal root in P^3 , less reduced P_3 and M_3 , longer trigonids and less rounded and centered talonids in P_4 - M_2 , with

a strong tendency to form lingual enamel bridges, and P_3 with less persistent lingual and anterolingual valleys, longer trigonids, and more rounded posterior borders.

Procaprolagus is also the only available North American candidate for ancestry of the enigmatic Miocene forms Hesperolagomys, Gripholagomys, Russellagus, Cuyamalagus, and ?Desmatolagus schizopetrus. Similarities include free buccal roots in P^4-M^2 (in the Miocene genera the buccal roots of P^3 are secondarily fused due to buccal expansion of the anterior lobe); moderate crown curvature; P_3 with short talonid, persistent lingual and anterolingual folds; P_4-M_2 with short trigonid, relatively long and rounded talonid, centered behind trigonid and not forming lingual enamel bridges; and P^3-M^2 with relatively persistent hypostria and buccal pattern. Although these forms have been referred tentatively to the Ochotonidae, maxillary fragments assigned to Gripholagomys and Hesperolagomys lack the premolar foramen. Although Hesperolagomys has the very reduced M_3 that would be expected in the Procaprolagus lineage, M_3 of Russellagus vonhofi is at least 2/3 as broad as M_2 , weakening the possibility of derivation from Procaprolagus.

In any event, at least Hesperolagomys and Gripholagomys appear to be leporids, and if they and their probable relatives were descended from any known lagomorph, Procaprolagus must be the leading contender for their ancestry.

To hypothesize yet one step farther from the data, it appears that the Procaprolagus lineage was a persistent though seldom sampled clade in North America, surviving at least through the mid-Miocene, and presumably inhabiting areas geographically or ecologically separated from those normally sampled in fossil assemblages.

Procaprolagus vusillus, sp. nov.

Fig. 14. A-U, Procaprolagus vusillus; A, LdP², P1654.893; B, LP², P1654.894; C, LP², P1654.895; D, RdP³, P1654.897, E, RP³, P1654.901; F, RP³, P1654.902; G, LdP⁴, P1654.904; H, LP⁴, P1643.5; I, LM¹, P1589.30; J, LM¹, P1654.912; K, LM², P1654.918; L, RM², P1589.31; M, RM³, P1654.925; N, RdP₃, P1654.929; O, RP₃, P1654.932; P, RP₃, P1654.933; Q, RP₃, P1654.934; R, RdP₄, P1654.943; S, LP₄ or M₁ or M₂, P1589.34; T, RP₄ or M₁ or M₂, P1654.962; U, LM₃, P1654.984. V, Leporidae, gen, et sp. indet., RP³, P1654.986. Anterior to left in A-C, G-K, N-R, T, to right in D-F, L, M, S, U, V. Scales 1 mm.



Palaeolagus? sp. Russell in Russell and Wickenden, 1933, p. 60.

Mytonolagus petersoni Burke, 1934; Russell, 1965a, p. 8.

Type. Holotype L mandibular fragment with P_3 - M_2 , ROM 1679.

Material. Holotype and LdP^2 , P1654.893; LP^2 , P1654.894-895; RP^2 , P1654.896; RdP^3 , P1654.897; LP^3 , ROM 23,597, P1654.898-900; RP^3 , ROM 23,598,23,599, P1654.901-903; LdP^4 , P1654.904-906; LP^4 , P1643.5, P1654.907; RP^4 , P1654.908-911; LM^1 , NMC 8653, P1589.30, P1654.912-915; RM^1 , P1654.916-917; LM^2 , P1654.918-923; RM^2 , P1589.31, P1654.924; RM^3 , P1654.925; upper tooth fragments, P1589.32, P1654.926,927; LdP_3 , P1589.33, P1654.928; RdP_3 , P1654.929; LP_3 , P1654.930-931; RP_3 , P1654.932-938; LdP_4 , P1654.939-942; RdP_4 , P1654.943-945; LP_4 or M_1 or M_2 , ROM 23,603, P1589.34, P1654.946-961; RP_4 or M_1 or M_2 , ROM 1680, ROM 23,604-23,606, P1589.35, P1654.962-983; LM_3 , P1654.984; RM_3 , P1654.985.

Diagnosis. Equal in size to P. vetustus, slightly smaller than P. gazini; P^3 buccal roots sometimes fused, normally free; P^2 lower-crowned, buccal loph smaller and less strongly separated from central loph than in P. vetustus; P^3 lingual loph extending to anterolingual base of central loph, overlapping weakly on anterior face; P^4 - M^2 hypostria, central basin, buccal pattern more persistent than in other species; P_3 with stronger lingual valleys, trigonid extending farther anterad than in P. vetustus; P_4 - M_2 with no tendency to form lingual enamel bridges, even in extremely worn specimens.

Etymology. Latin vusillus, woozle, an elusive, diligently hunted beast (Lenard, 1960, p. 23; Milne, 1935, p. 32).

Description. Cheek teeth relatively low-crowned; cement lacking; P^3 - M^2 markedly unilaterally hypsodont; P^2 , M^3 , lower cheek teeth, deciduous teeth slightly unilaterally hypsodont; M^1 - M^2 strongly curved lingually.

dP^2 (Fig. 14A) central lobe bulbous, occupying most of crown; buccal lobe small, oriented anterobuccad, connected posteriorly to central lobe by high ridge, forming shallow anterobuccal valley; lingual lobe

long, narrow, forming complete lingual and posterior cingulum, connected to buccal lobe and appressed against posterolingual face of central lobe. Crown height, anterior face, P1654.893, 0.9.

P² (Figs. 14B,C) lingual lobe terminating at lingual edge of central lobe, thickening into posterolingual cusp. One specimen apparently lacking buccal lobe. Crown height, anterior face, P1654.895, 1.5.

dP³ (Fig. 14D) hypostria extending more than half way from lingual border to crescentic valley in little-worn specimen, terminating within 0.7 mm of crown base; lingual lobe extending to buccal wall anterior to central lobe; crescentic valley not reaching buccal crown border. Maximum crown height, lingual face, P1654.897, 2.1.

P³ (Fig. 14F) buccal lobe reaching as far anterad as central lobe; lingual lobe reaching anterior end of central lobe but not onto its anterior face; lingual hypostria very shallow, persisting to within 1.7 mm of crown base; buccal roots in three specimens separate, free except for first millimetre dorsal to crown base, but four other examples show single buccal root with anteroposteriorly elongate pulp cavity. Maximum crown height, lingual face, P1654.903, 3.2.

A nearly unworn fragment of P³ (Fig. 14E) shows additional details of pattern, and a variant in relative valley depths. The central and buccal lobes are joined by a high ridge, with the lingual lobe joined posteriorly to the buccal lobe. Unlike the situation in other specimens, the valley between the central and buccal lobes extends nearly to the crown base, central and buccal lobes have anterior cusps, and the lingual lobe slightly overlaps the anterior face of the central lobe.

dP⁴ (Fig. 14G) hypostria prominent, extending slightly farther buccad than in dP³ and persisting to within 1 mm of crown base; lingual lobe apparently terminating anterior to central cusp, not reaching buccal edge of crown. Maximum crown height, lingual face, P1654.904, 2.2

P⁴ (Fig. 14H) nearly unworn pattern showing large, V-shaped central cusp occupying much of occlusal surface; large, bulbous buccal cusp, broader posterad, covering entire buccal surface and isolating triangular basin within arms of central cusp; small anterolingual and posterolingual cusps, separated lingually by shallow hypostria, connected by cusps anterior and posterior cingula to arms of central cusp; crown height on lingual surface, P1643.5 (not all enamel formed), 3.7.

In worn specimens valley buccal to central cusp isolated into medium crown wear; buccal roots separate, free except first 0.8 mm; hypostria persisting to within 3.3 mm of crown base; maximum crown height, P1654.907. 5.5

Little-worn M¹ (Fig. 14I) with oval basin posterobuccal to central cusp; hypostria extending posterobuccad nearly 1/4 way across crown, persisting to within 1.4 mm of crown base; buccal roots free except first 0.6 mm; maximum crown height, P1589.30, 4.8.

More worn specimens (Fig. 14J) with buccal enamel margin not reached in very late wear; crown very transverse, with only slight reduction of posterobuccal corner; central valley remnants very persistent, traces seen when lingual crown height reduced to 1.6 mm.

Little-worn M² (Fig. 14L) reduced posterobuccally and posterolingually; hypostria extending buccad, not as far as in M¹, about half way from lingual border to crescentic valley, and persisting to within 1 mm of crown base; buccal roots free except first 1.1 mm; maximum crown height, lingual face P1589.31, 4.6.

More worn M² (Fig. 14K) with buccal enamel margin not reached in very late wear; crown not as transverse as in M¹, posterior face slightly concave, posterobuccal corner very reduced; crescentic valley remnants very persistent, well-defined enamel lakes seen when lingual crown height reduced to 2.8 mm, obliterated in specimen with 2.1 mm lingual crown height.

M³ (Fig. 14M) represented by single specimen; crown very reduced, single-rooted; barely unilaterally hypsodont (lingual 2.0, buccal 1.4); trigon U-shaped; remnant of central cusp at buccal margin of crown; talon developed only lingually; hypostria strong, separating talon and trigon, but shallow, ending 1.5 mm from crown base.

dP₃ (Fig. 14N) posterolophid well defined to within 0.7 mm of crown base; posterior lobe relatively broad, long; anterior lobe a low, conical cusp attached lingually to central lobe; either anterior or posterior lobe can join central lobe first, depending on wear pattern; maximum crown height, lingual face central lobe, P1654.929, 1.2.

Worn P₃ as described, figured by Russell (1965a, p. 9; pl. 6, fig. 1). Little-worn specimens (Figs. 14O-Q) with trigonid, talonid strongly united linguad, lingual valley terminating 2.2 mm above crown base and obliterated with moderate wear, buccal valley persisting to within 1.4 mm of crown base; posterolophid separated lingually only in least worn specimen, posterolingual fold terminating 1.9 mm above crown base; trigonid nearly as wide basally as talonid; trigonid with prominent anterolingual fold, persisting to within 1.6 mm of crown base; maximum crown height, anterobuccal face, 3.6; root single, grooved lingually and buccally.

Least-worn dP₄ (Fig. 14R) with well-developed posterolophid, set off lingually and buccally by folds persisting to within 0.6 and 0.3 mm of crown base, respectively; talonid slightly longer, broader than trigonid; maximum crown height, buccal face of trigonid, 1.6.

P₄-M₂ worn patterns as described, figured by Russell (loc. cit.); P₄ slightly narrower than M₁₋₂; least worn teeth (Fig. 14T) with strong posterolophid, set off lingually and buccally by folds persisting to within 2.1 and 1.6 mm of crown base, respectively; trigonid very short anteroposteriorly, expanding somewhat near crown base, separated from talonid to within 0.4 mm of crown base; talonid much longer than trigonid except in some specimens worn to near crown base; talonid shape depending upon wear stage and position in tooth row; weak

anterolingual fold, sharp anterobuccal notch present in earliest wear, talonid nearly oval with weak anterobuccal notch after joining of posterolophid, talonid subrectangular in latest wear (Fig. 14S); talonid centered behind trigonid, never forming lingual enamel bridge; greatest crown height, P1654.962, 4.5.

M₃ (Fig. 14U) reduced, single-rooted; talonid as high as trigonid, nearly as broad, slightly longer anteroposteriorly, separated only buccally by valley persisting to within 1.2 mm of crown base; maximum height, P1654.984, 2.2.

Discussion. Procaprolagus vusillus differs from P. vetustus in minor details: P² is slightly lower-crowned, with a smaller buccal lobe; P³ buccal roots are unfused and free in only about half the specimens that are well enough preserved to show the feature; the hypostria, central basin, and buccal pattern are more persistent; P₃ has stronger lingual valleys and a longer trigonid; and P₄-M₂ shows no tendency to form lingual enamel bridges, even in extremely worn specimens.

Of these characters, most indicate a more primitive species than P. vetustus, as would be expected from the greater age of P. vusillus. Lower crown height is surely primitive. Incomplete separation of buccal roots in P³ may reflect the condition seen in more primitive lagomorphs such as Lushilagus (Li, 1965, p. 9), in which both P³ and P⁴ have single buccal roots: in Mytonolagus petersoni, P³ has only one buccal root, while in the later and more advanced M. wyomingensis the P³ buccal root shows some sign of separation into two parts (Dawson, 1970, p. 216).

Greater persistence of the hypostria, central basin, and buccal pattern is generally regarded as a primitive character among lagomorphs (Dawson, loc. cit.). Lack of lingual enamel bridges in P₄-M₂ is more difficult to analyze: enamel bridges generally are stronger in more advanced members of lagomorph lineages, but strong separation of

trigonid and talonid is to some degree a peculiarity of Procaprolagus, and is better developed than in the generally more primitive Shamolagus (Burke, 1941, Li, 1965).

P. gazini (Burke, 1936) appears to show less retention of pattern in P^4-M^2 , and is slightly larger: P. gazini and P. vusillus are difficult to distinguish, and will remain so until more specimens of P. gazini are available for analysis.

P. vusillus is among the earliest North American lagomorphs, about the same age as the first known Mytonolagus. Neither of the North American Uintan lagomorph genera can be tied closely to contemporaneous Asiatic lineages, although Procaprolagus shows more characters reminiscent of Lushilagus and Shamolagus, as Dawson (1970, p. 230) has noted. Marked similarity with the Oligocene Asiatic P. vetustus makes the problem even more tantalizing.

Measurements. Holotype ROM 1679: P_3 AP, 2.13; BLtri, 1.68; BLtal, 1.65. P_4 AP, 2.49; BLtri, 2.64; BLtal, 1.86. M_1 AP, 2.52; BLtri, 2.88; BLtal, 2.16. M_2 AP, 2.54; BLtri, 2.85; BLtal, 2.19.

Mandible ROM 23,602: P_3 AP, 2.02; BLtri, 1.74; BLtal, 1.83. P_4 AP, 2.28; BLtri, 2.61; BLtal, 1.98.

Isolated teeth: dP^2 AP(1) 1.35; BL(1), 1.20. P^2 AP(3), mean 1.25, OR 1.17-1.40; BL(3), mean 1.65, OR 1.48-1.92. P^3 AP(8), mean 1.77, OR 1.60-1.85, CV 4.5; BL(7), mean 3.27, OR 2.90-3.50, CV 6.9. dP^4 AP(2), mean 1.79, OR 1.74-1.84; BL(1), 3.25. P^4 AP(5), mean 2.06, OR 1.92-2.18, CV 4.7; BL(3), mean 3.36, OR 2.96-3.57. M^1 AP(6), mean 1.94, OR 1.80-2.10, CV 5.3; BL(3), mean 3.74, OR 3.12-4.80. M^2 AP(7), mean 1.78, OR 1.59-1.93, CV 6.1; BL(5), mean 3.74, OR 3.00-4.45, CV 16.6. M^3 AP(1), 1.18; BL(1), 1.18. dP_3 AP(1), 2.13; BLtri(1), 1.28; BLtal(2), mean 1.35, OR 1.20-1.50. P_3 AP(10), mean 1.77, OR 1.50-1.95, CV 8.6; BLtri(10), mean 1.48, OR 1.27-1.84, CV 12.9; BLtal(10), mean 1.55, OR 1.34-1.95, CV 11.8. dP_4 AP(5), mean 2.14, OR 1.96-2.32, CV 6.3; BLtri(5), mean 1.67, OR 1.53-1.75, CV 5.4; BLtal(5), mean 1.82, OR

1.65-1.90, CV 5.6. P_4 or M_1 or M_2 AP(38), mean 2.34, or 2.00-2.80, CV 6.8; BLtri(36), mean 2.45, OR 2.04-2.85, CV 6.9; BLtal(41), mean 1.92, OR 1.70-2.16, CV 5.4. M_3 AP(1), 1.38; BLtri(1), 1.35; BLtal(1), 1.25.

Leporidae, gen. et sp. indet.

Material. RP^3 , P1654.986.

Description. P^3 (Fig. 14V) large; lingual lobe overlapping well onto anterior face of central lobe; posterior cingulum apparently developed.

Discussion. This poorly-preserved fragment is the only indication of a lagomorph much larger than Procaprolagus vusillus.

Apparent development of a posterior cingulum may indicate that dP^3 is represented. Extent of the lingual lobe approximates that of Oligocene Megalagus, and size is about that of M. turgidus.

Measurements. P^3 AP(1), 3.28.

CORRELATION

Russell (1965a, p. 18), analyzing the faunal list as known then, concluded that "the closest resemblances appear to be with the fauna of the Upper Uinta or Myton Member." His statement is still true, although it appears that only half of the Swift Current Creek Local Fauna is duplicated in other assemblages.

The local fauna is generally of Uinta C aspect. Selenodont artiodactyls are numerous and diverse, and somewhat advanced over species typical of Uinta B; uintatheres are apparently absent (Golz, 1976, p. 13); and lagomorphs are present. In contrast with Duchesnean assemblages, more advanced artiodactyls such as Hendryomeryx (Black,

1978) are absent, dichobunid artiodactyls are represented by two species (op. cit.), and an advanced Hyopsodus is one of the more common members of the fauna (Krishtalka, 1979: Hyopsodus is known from only one Duchesnean fauna. It is apparently more advanced than the Swift Current H. fastigatus).

Co-occurrence of several species with well-known, short biostratigraphic ranges ties the Swift Current Creek Local Fauna to the fauna of the Myton Pocket, Uinta C of Utah. Prodaphoenus scotti, Epihippus gracilis, Mytonomeryx scotti, Leptoreodon marshi, and Pseudotomus eugenei are typical of the Myton Pocket assemblage, and indicate that the faunas are similar in age. Moreover, species of Auxontodon and Janimus are similar, though not identical, and the longer-ranging Protoreodon pumilus occurs in both faunas.

The Swift Current Creek Local Fauna has several taxa in common with Badwater localities 5, 6, and 7, which are nearly correlative with the Myton pocket, probably very slightly later (Dawson, 1970). These include five marsupial taxa, Apatemys hendryi, Thylacaelurus campester, Epihippus cf. E. gracilis, Leptotomus near L. guildayi, and Pseudotomus cf. P. eugenei, with similar species of erinaceid, Centetodon, soricid, Oligoryctes, Auxontodon, and Leptoreodon.

The Saskatchewan assemblage is less similar to more distant local faunas of west Texas and California. The Candelaria Local Fauna (Wilson, 1978, table 1) was correlated as Uinta C, "post-Myton in age but probably not much later" (Wood, 1974, p. 105), and contains Epihippus cf. E. gracilis, Protoreodon pumilus, and Leptoreodon marshi. The faunal assemblage of the Santiago Formation (Golz and Lillegraven, 1977) yields Protoreodon pumilus, a rather similar omomyid primate, and a similar species of "Namatomys" (Chiment, 1977).

Thus the Swift Current Creek Local Fauna is certainly of late Uintan (Uinta C) age, and shows strongest similarities to the faunas of the Myton Pocket and Badwater localities 5, 6, and 7. It seems reasonable

to regard the Candelaria Local Fauna of West Texas and the fauna of the Santiago Formation of southern California as roughly contemporaneous, though similarities are less strong.

The Swift Current Creek Local Fauna correlates with faunas in the 42-44 MYBP age range (Berggren et al., 1978, fig. 2; Golz and Lillegraven, 1977, fig. 6).

PALEOECOLOGY

Although only one group of animals (Mammalia) is treated in this paper (and only the teeth and jaws of the mammals have been studied), and plant remains and other direct indicators of habitat and climate are missing, much paleoecological evidence is available from the geology and faunal sample of the deposit.

It appears that the Swift Current Creek Local Fauna, though certainly a thanatocoenose, represents the fauna of a limited area. The fossil mammals inhabited a wide river valley, probably dominated by closed-canopy woodland formations. Mammalian diversity in both species richness and equitability of representation was high, indicating ecological stability. The preserved sample represents the fauna in late spring or early summer, transported and deposited in a fast-flowing stream at the time of peak seasonal rainfall and stream discharge.

The available evidence, to be summarized in the following sections, gives a fairly reliable general picture of conditions within the stream valley. Similar environments may well have prevailed in major river valleys throughout the northern Great Plains. No evidence is available for environments of the upland interfluvies in the later Eocene plains.

GEOLOGICAL EVIDENCE

The geology of the Swift Current Creek deposits, mostly based on the work of Vonhof (1965a, b, 1969) was summarized earlier in this paper. Deposits associated with Swift Current localities are poorly sorted gravels, sands, and conglomerates laid down as bars in a braided stream. The prevalent materials (near 90%) are silicates derived from the Rocky Mountain front more than 400 km distant. A broad, easterly-trending valley at least 61 metres deep was present: the fossil localities are in the valley thalweg.

Faunas recovered from channel deposits are generally assumed to present thanatocoenoses. In this instance, it is certain that all material was transported by the stream to the place of deposition: the deposits are those of a high-energy depositional environment, and the fossils are disarticulated, usually isolated teeth, bones, and fragments.

Disregarding the finer points of transportation of bone in water, it can be hypothesized that the teeth and bones were transported as if they were sand grains or pebbles. As current slackened, bars were built and the fossils were deposited along with other water-carried material.

Channel deposits of the kinds represented at the fossil localities are typical of braided streams with high, seasonal discharge (Ore, 1964). Deposition in such a system is rapid, and occurs when flow is high.

Streamflow on the order of 400-500 cm/sec (Gilluly *et al.*, 1959, fig. 12-7) was necessary to transport coarse materials including cobbles in the 32-64 mm size class (Vonhof, 1969, fig. 6.6). Local gradients have been estimated at only 0.75-1 metre per kilometre (Vonhof, 1969, p. 91), an estimate that is almost certainly too high because late Cenozoic differential uplift has exaggerated the apparent slope of the Eocene land surface (Eardley, 1962, fig. 31.25). The Swift Current localities are more than 400 km away from the source area of the sand and gravel clasts, and from the headwaters of the stream.

Such high streamflows, with low local gradients and great distance from stream headwaters, must have been caused by torrential seasonal rains. "Widespread tropical showers of the monsoonal type during late spring and early summer" (MacGinitie, 1969, p. 53) appear to have become prevalent in the later Eocene, and would account for the situation seen in the Swift Current deposits.

LOCAL SOURCE FOR FOSSILS

Fossils of the Swift Current Creek Local Fauna, though surely transported by the stream to the point of deposition, appear to represent the fauna of a limited area, and may not have been transported far. Three independent lines of evidence indicate a fairly restricted source for the fossils:

Abrasion of teeth. 119 of 1118 identified specimens from the Swift Current Creek Locality, or 10.6%, show recognizable abrasion. In this category I include obviously rounded specimens that have lost enamel from abrasion other than occlusal or interdental wear, and I do not include merely broken (sometimes shattered) specimens, or specimens that show only chemical etching.

Proportionally, the abraded teeth are evenly divided among the reported taxa, with "rolled" specimens over-or underrepresented only in small samples ($N \leq 10$): exceptions are Peratherium innominatum (20 of 93 specimens) and Centetodon aztecus (5 of 27 specimens).

I am not aware of relevant experimental data, but I assume that transport of teeth and bones in a high energy situation, in a stream load where nearly all particles above silt size were silicate grains, would produce a high degree of abrasion with even moderate distance.

Normal distribution of data. Kolmogorov-Smirnov one-sample tests were performed on all sets of measurements where $N \geq 5$. This test, as described by Daniel (1978, p. 267 ff.), can be used to test goodness of fit of discontinuous data to a normal distribution, and is more sensitive than the chi-square test.

A conservative 90% level of rejection was selected, using Conover's (1971, table 15) "Quantiles of the Lilliefors test statistic."

108 series of measurements were tested, representing 50 groups of teeth from 14 species. The hypothesis of normal distribution of data was rejected at the 90% level for 20 series: 17 of these were measurements of teeth that passed at the 90% level on other series of measurements.

Three series of measurements cannot be normally distributed, and are not linked to other series that are. These are Centetodon aztecus P_4 (BL), Hyopsodus fastigatus P_4 (BL), and Oromerycidae, gen. et sp. indet. P^3 (BL).

97% of measurement series tested are normally distributed or are linked to series that are; or perhaps more simply, 94% of tooth positions tested have normally distributed measurements.

Thus it appears that only minimal changes in size characteristics of the sample came about as a result of transport and deposition, implying that the distance of transport may have been short.

The prevalence of normally distributed data also means that the sample means, standard deviations, and other statistics implying normal distribution are likely to be significant in terms of the original populations, and that the results of parametric tests would be meaningful.

Evenness of preservation. An index of differential preservation was described by Holtzman (1979). This index, presented as m_i^*/m_i in Table I, was developed to aid in analysis of abundance estimates made by the

Table 1. Raw data and relative abundance estimates for mammals of the Swift Current Creek Local Fauna. n_i - number of specimens, e_i - number of elements, m_i - number of elements per individual, e_i' - most abundant element m_i'/m_i - index of differential preservation, WAE - weighted abundance of elements method, MNI - minimum number of individuals method.

Taxon	n_i	e_i	m_i	e_i'	m_i'/m_i	Frequency	
						WAE	MNI
<u>E. lovei</u>	6	6	16	3	0.125	0.008	0.019
<u>P. marsupium</u>	76	76	24	8	0.396	0.070	0.052
<u>P. knighti</u>	36	36	24	3	0.500	0.033	0.019
<u>P. innominatum</u>	91	92	24	7	0.548	0.084	0.045
<u>P. californicus</u>	5	5	24	2	0.104	0.005	0.013
<u>P. cf. minutus</u>	4	4	24	1	0.167	0.004	0.006
"P." <u>mcgrewi</u>	1	1	24	1	0.042	0.001	0.006
<u>P. borealis</u>	10	10	28	2	0.179	0.008	0.013
<u>Leptictis</u> sp.	19	19	28	3	0.226	0.015	0.019
<u>A. hendryi</u>	1	1	16	1	0.063	0.001	0.006
<u>D. serus</u>	12	12	20	2	0.300	0.013	0.013
<u>T. campester</u>	9	9	24	2	0.188	0.008	0.013
Adapisoricid	4	4	20	2	0.100	0.004	0.013
Erinaceid	12	12	20	2	0.300	0.013	0.013
<u>Nyctitherium</u> sp.	1	1	20	1	0.050	0.001	0.006
<u>C. aztecus</u>	27	28	20	6	0.233	0.031	0.039
<u>W. scalopidens</u>	6	6	20	1	0.300	0.007	0.006
<u>Domnina</u> sp.	1	2	20	1	0.100	0.002	0.006
Soricid sp. A	12	12	20	3	0.200	0.013	0.019
<u>Oligoryctes</u> sp.	4	4	20	1	0.200	0.004	0.006
Insect, incert.	1	2	16	1	0.125	0.003	0.006
Chir. sp. 1	8	8	20	2	0.200	0.009	0.013
Chir. sp. 2	1	1	20	1	0.050	0.001	0.006
Omomyid sp. 1	2	2	20	2	0.050	0.002	0.013
Omomyid sp. 2	1	1	20	1	0.050	0.001	0.006
<u>Viverravus</u> sp.	1	1	16	1	0.063	0.001	0.006

	n_i	e_i	m_i	e_i'	m_i'/m_i	Frequency	
						WAE	MNI
<u>P. cf. scotti</u>	1	1	20	1	0.050	0.001	0.006
Caniform sp. 1	5	5	20	2	0.125	0.005	0.013
Caniform sp. 2	4	4	20	1	0.002	0.004	0.006
<u>Harpagolestes</u> sp.	1	1	20	1	0.050	0.001	0.006
<u>H. fastigatus</u>	106	106	36	11	0.268	0.065	0.071
<u>E. cf. graci's</u>	8	8	44	1	0.182	0.004	0.006
Brontotheriid	2	2	36	1	0.056	0.001	0.006
<u>C. cf. kayi</u>	8	8	32	2	0.125	0.005	0.013
<u>Dilophodon</u> sp.	1	1	36	1	0.028	0.001	0.006
<u>M. scotti</u>	5	5	28	1	0.179	0.004	0.006
<u>A. processus</u>	13	13	28	2	0.232	0.010	0.013
<u>I. ignotus</u>	26	26	32	3	0.271	0.018	0.019
Oromerycid	64	65	28	5	0.464	0.051	0.032
<u>P. pumilus</u>	25	25	28	2	0.446	0.020	0.013
<u>L. marshi</u>	111	120	32	8	0.469	0.082	0.052
<u>Leptotomus</u> sp.	10	10	20	2	0.250	0.011	0.013
<u>L. nr. guildayi</u>	1	1	20	1	0.050	0.001	0.006
<u>P. cf. eugenei</u>	9	9	20	2	0.225	0.010	0.013
<u>M. dubius</u>	8	8	20	3	0.133	0.009	0.019
<u>M. solidus</u>	27	27	20	3	0.450	0.030	0.019
<u>P. citofluminis</u>	6	6	20	2	0.150	0.007	0.013
Prosciurine	2	2	20	1	0.100	0.002	0.006
<u>"N." fugitivus</u>	156	156	20	19	0.410	0.172	0.123
<u>P. altilophus</u>	29	29	20	5	0.290	0.032	0.032
<u>J. mirus</u>	28	28	20	4	0.350	0.031	0.026
<u>P. vusillus</u>	111	115	32	9	0.399	0.079	0.058
Leporid, indet.	1	1	32	1	0.031	0.001	0.006

Totals	1120	1138		154		0.999	0.984
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"weighted abundance of elements" method (WAE). I present a complete table based on Holtzman's (1979, table 1), to make the data available for comparison.

The index of differential preservation is a helpful statistic for species whose representative samples are large ($e_i \geq m_i$) (op. cit., p. 82). In smaller samples the index cannot reach its maximum value (for even preservation of elements $m_i/m_i \rightarrow 1$), and artificially low values are obtained.

In large Swift Current samples ($e_i \geq m_i$) the index of differential preservation is a normally distributed statistic ($N=12$, mean 0.398, OR 0.233-0.548, $s=0.097$: probability that distribution is not normal <0.80). For 21 samples where the number of specimens is 10 or more, the observed range is not much greater (0.179-0.548).

Thus for large samples, preservation of elements is relatively even, and the index of differential preservation is comparable for well-represented taxa. Minimal changes in characteristics of the sample were brought about as a result of stream transport, implying that the distance of transport may have been short.

REPRESENTATION OF A SEASON

Geological evidence indicates deposition at the fossil localities at times of heavy rainfall and stream discharge, in late spring or early summer. Presence of a significant percentage of juvenile animals in the assemblage also suggests mortality and preservation predominantly in spring or early summer.

Of the teeth from the Swift Current Creek Locality, 231 (20.6%) represent young individuals, with nearly unworn permanent teeth (138) or deciduous teeth (93). Probably most significant are groups of small

mammals that have generally short lifespans, and show very rapid growth, replacement of deciduous dentition, and wear of permanent dentition, reaching adulthood in the first season:

- Marsupials, 30 of 213 specimens (14.1%)
- Insectivores, 13 of 68 specimens (19.1%)
- Rodents: 49 of 277 specimens (17.7%)
- Lagomorphs: 22 of 112 specimens (19.6%)

I have not attempted to place all teeth into age groups (taking probable lifespans and sequences of dental replacement into account), and my designation of teeth as "nearly unworn" is arbitrary and subjective, but generally conservative. I suspect that these data underestimate the proportions of very young individuals.

The proportion of young of the year, especially among the small mammals, suggests that mortality took place soon after parturition, i.e., for a seasonal climate, in the spring or early summer.

TAPHONOMIC HYPOTHESES

The taphonomic situation represented in a channel bar deposit is likely to be complex. Behrensmeyer (1982) summarized some of the possibilities involved, and presented evidence from field observation and theory to support a general taphonomic picture for channel assemblages.

Bone reaches fluvial channel deposits through three pathways (op. cit., p. 219): "A) initial autochthonous burial in the floodplain soil, followed by partial destruction and/or reworking through bank erosion, B) overland transport directly into the channel, and C) carcasses or bones originally in the channel." It appears to me that pathway A was a minor factor in Swift Current fossil preservation: the proportion of teeth representing very young animals suggests predominantly seasonal mortality, while I assume floodplain soils would preserve the results

of year-round mortality, possibly with a bias against juveniles (op. cit., p. 217). Possibly spring floods collected animal remains from the surface, although one cannot rule out carnivores or owls as factors in concentrating small mammal remains in the floodplain.

Behrensmeyer (op. cit., p. 214) pointed out that "channel assemblages may represent periods of time that are long relative to the final transport and burial events because bones may be held in 'temporary storage' within the fluvial system and subjected to one or more cycles of reworking." Although I do not think that storage in floodplain soils was an important factor in the accumulation of this assemblage, I consider it probable that at least some components of the Swift Current Creek Local Fauna were "stored" in the channel deposits, and reworked from bar to bar as the stream system changed course. Thus a great many years' seasonal mortality could be represented in the assemblage while, if conditions of sampling were similar from year to year, a reasonably uniform representation of the valley species (normal distribution of data, even preservation) might still make its way to the final deposits. The length of time involved in forming the fossil assemblage cannot be determined, but it need not be as long as 10^2 - 10^3 years (op. cit., p. 216), a figure based on contribution of bone through floodplain preservation and subsequent bank erosion.

The foregoing considerations suggest two alternate hypotheses to account for 10.6% of the teeth being abraded. 1) The fossil remains could all have been relatively locally derived, with a small proportion showing abrasion from short-term "storage" in bars and reworking: perhaps the abraded teeth are slightly older. Or perhaps abrasion simply came from differential exposure to silicate grains during short transport. 2) Most of the fossil remains could be locally derived, with a small component coming from farther upstream and exposed to greater transport and abrasion: if this was the case, it appears that the more distant component was drawn from a similar mosaic of habitats. In either case, at least 89% of the teeth and jaws were apparently

locally derived, total distance of transport was not great (whether the result of one episode or several), and the fossil material is likely to be consistent in representing a set of associated habitats.

ECOLOGICAL STABILITY

Some general information on ecological stability can be gained through analysis of faunal diversity, as applied to late Paleocene and early Eocene faunas by Rose (1981, p. 141 ff.).

Species richness in the Swift Current Creek Local Fauna was high (53 mammalian species known from 1120 specimens). Diversity is surpassed by a few Paleocene-to-Oligocene local faunas: Torrejonian Rock Bench Quarry (57 spp., 1687 specimens: op. cit.); Uintan Badwater localities 5, 6, and 7 (probably about 60 spp, sample size large but not completely reported; Black, 1970, 1971, 1974, 1978, 1979; Black and Dawson, 1966; Dawson, 1970, 1974, 1980; Krishtalka, 1978, 1979; Krishtalka and Black, 1975; Krishtalka and Setoguchi, 1977; Krishtalka and Stucky, 1983a, b; Lillegraven et al., 1981; Robinson, 1966, 1968b; Setoguchi, 1975); and Chadronian Calf Creek Local Fauna (SMNH sample 63 spp., 2900 specimens: Emry and Storer, 1981; Krishtalka et al., 1982; Russell, 1978, 1982; Storer, 1978b, 1981a, b; unpublished data). Species richness is comparable to other known Torrejonian to Chadronian assemblages, considering sample size.

Calculation of diversity indices (based on minimum number of individuals for comparability with data in Rose, 1981) yields:

- Simpson index (1-L), 0.965
- Shannon index (H'), 3.52
- Whittaker index (E), 40.4

These indices compare well with those from Torrejonian assemblages (op. cit., table 55), are somewhat higher than those from Wasatchian faunas, and are well above those from known Tiffanian and Clarkforkian faunas.

Moreover, the rank abundance curve that could be drawn from frequency distribution of Swift Current mammals is rather close to the theoretical line predicted from the MacArthur model (Type I distribution) and would compare favorably with the curve for the Torrejonian Rock Bench Quarry (op. cit., fig. 77A).

Thus it appears that the Swift Current Creek mammals lived in a situation of a "general ecological stability" (op. cit., p. 179), rather than unpredictability.

Such a strong indication of stability is surprising: general evidence for later Eocene instability is overwhelming, though it appears that the greatest drop in mean annual temperature had not yet occurred by the late Uintan (Wolfe, 1978). By the late Uintan, however, worldwide climatic change (Lillegraven, 1979, pp. 342-344) and tectonism in the Rocky Mountains (Russell, 1954b) interacted to produce changes in the climate of the continental interior. In response to increased climatic seasonality, particularly seasonally distributed rainfall, broken-canopy and open-canopy vegetational formations began to replace closed-canopy formations, apparently beginning in the later middle Eocene in California (Lillegraven, 1979, p. 338), and well documented for the middle and late Eocene of the Rocky Mountain region (Webb, 1977).

I suspect that the fauna indicates such strong ecological stability because it represents the mammals of the river valley. Even though rainfall was seasonal, water was available throughout the year at the valley bottom, and seasonal aridity, such as might have been encountered on the 60-metre higher upland interfluves, was not an important factor in the valley.

ENVIRONMENT

Evidence of vegetation is entirely lacking in the Swift Current Creek deposits. One can only guess at the environment in which the fauna lived.

Black (1978, pp. 227-229) postulated that diversity of bunodont artiodactyls declined with the spread of savanna vegetational formations, while diversity of selenodont artiodactyls increased dramatically.

The Swift Current Creek Local Fauna shows the highest diversity of bunodont artiodactyl species among contemporaneous local faunas (Table II), and the lowest diversity of selenodont species. Comparisons of generic diversity give similar results.

Thus it would appear that the broad valley in which Swift Current fossils were deposited was considerably behind sampled areas in west Texas, the Rocky Mountain region, and California in development of savanna environments, and included major areas of closed-canopy woodland.

That a significant component of abrasive plant material was present in or near the area is indicated by the abundance of Leptoreodon and an oromerycid, and the presence of Protoreodon. Among other groups, Hyopsodus fastigatus shows marked increase in tooth crown height and lophiodonty over earlier species, and is slightly advanced over the contemporary H. uintensis; H. fastigatus too may have been adapted to eating more abrasive plant material than its predecessors or contemporaries (Gazin, 1968, p. 33).

Table II Diversity of contemporaneous Uinta C artiodactyls (modified from Black, 1978, table 2: sources Black, 1978; Gazin, 1955; Golz, 1976; Golz and Lillegraven, 1977; Wilson, 1971, 1974).

Fauna	Number of genera		Number of species	
	bunodont	selenodont	bunodont	selenodont
Santiago Formation (California)	0	5	0	10
Myton Pocket (Utah)	2	5	2	7
Badwater 5, 6, 7 (Wyoming)	2*	6	2*	6
Candelaria (Texas)	0	3	0	4
Swift Current	3	3	3	3

* I recognize only Apriculus and Auxontodon in Badwater 5, 6, 7.

As with apparent ecological stability, the supposition of closed-canopy woodland in the valley cannot be extended to the uplands. The presumed environment may have been the dominant one for the Great Plains, but could easily have been unusual, and found only in deep river valleys.

Other evidence from the Plains does not encourage speculation. The only other reported later Eocene fauna from the Plains is the Antelope Creek Local Fauna from South Dakota (Bjork, 1967), which is Duchesnean (included in the Oligocene by some authors: Emry, 1981). The Antelope Creek Local Fauna contains only ten taxa, six of them mammals, and is closely associated with stream and nearby environments (Bjork, 1967, p. 229).

PROVINCIALITY IN THE UINTAN

The Swift Current Creek Local Fauna demonstrates a high degree of endemism among the mammals, and at first glance appears to establish the Great Plains as a distinct biogeographic province in the later Eocene. Further consideration inclines me toward caution: the fauna is so closely associated with the stream valley that no conclusion is presently possible.

There is good evidence that the West Coast (Golz and Lillegraven, 1977) and west Texas (Wilson, 1978; Wood, 1974) were distinct faunally from the Rocky Mountain region in later Eocene time. It appears that California was increasingly cut off from other areas during the Uintan (Golz and Lillegraven, 1977): Lillegraven (1979) concluded that the isolation of West Coast faunas was caused by both mountain-building and worldwide late Eocene differentiation of climate, climatic change probably being the more important factor. The peculiar character of the west Texas fauna may have been caused by presence of a distinct Middle American element (Wood, 1974, p. 102), parts of which could also have contributed to California faunas.

The Swift Current assemblage contains few species that are identical with or very similar to those found in contemporaneous west Texas (7%) or California (16%) mammalian faunas.

Resemblance to faunas from the Rocky Mountain region is greater. 20 species are identical to contemporaneous Uinta Basin or Badwater forms, nine are close relatives, and two (eomyid rodents) will probably be found to be related to undescribed forms. 58% resemblance to contemporaneous Rocky Mountain faunas is shown.

42% of Swift Current species are markedly distinct from contemporaneous forms found elsewhere. This high degree of endemism could be explained either as an indication that well-separated biogeographic provinces are

represented, or that the Swift Current mammals inhabited an environment that had no close counterpart in the intermontane basins, but was not representative of the entire Great Plains.

Because no evidence is available for the upland areas, which could have been more similar to the intermontane basins, the matter must be considered unsettled.

CONCLUSIONS

Analysis of the geology and faunal sample of the deposits leads to a series of paleoecological conclusions. It appears that the fauna represents a limited area of river valley, probably dominated by closed-canopy woodland. General ecological stability prevailed. The preserved fauna appears to represent the results of spring or early summer mortality and deposition, although it is likely that many years of seasonal mortality are represented in the sample. A relatively restricted and perhaps unusual ecological situation is represented, and the interpretation I have given the evidence dictates against generalizing to upland areas, or to the Great Plains as a whole.

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